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SANITATION
OF
MOFUSSIL BAZAARS

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SANITATION

OF

MOFUSSIL BAZAARS

BY

G. W. DISNEY

ASSOCIATE, KING'S COLLEGE, LONDON; MEMBER, INSTITUTE, CIVIL ENGINEERS; FELLOW ROYAL SANITARY INSTITUTE; LATE SANITARY ENGINEER TO GOVERNMENT, EASTERN BENGAL AND ASSAM

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THIRD EDITION

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THIRD EDITION

DEDICATED

TO

Sir Lancelot Hare, K.C.S.I., C.I.E.,

LATE LIEUTENANT-GOVERNOR OF EASTERN BENGAL AND ASSAM.

Under whom the Author had the honour of serving for many years

RANCHI,
The 17th June 1914.

PREFACE TO THIRD EDITION.

THE Second Edition of this work being now out of print for some years it has been suggested to me that I should re-write the Manual and bring it up to date. It does not purport to be a highly technical work, but will, I trust, indicate to those requiring fuller information where to look for it. Two Chapters have been added on Road Making and Building Construction which, it is hoped, will make the book more useful to those for whom it is written. The arrangement of the Chapters has also been altered.

My acknowledgments are again due to many friends who have helped me in revising the Second Edition of this Manual.

RANCHI,
17*th June* 1914.

G. W. D.

INTRODUCTION.

A CONCISE handbook dealing with the most important points of the sanitation of Indian Bazaars is much needed; this is an endeavour to supply the want and put the information available on the subject in a convenient form, so as to facilitate the organization, and control the working of the sanitary department of a municipality. It is not within the scope of this work to allude to large waterworks or drainage schemes, but merely to show how existing arrangements can be improved.

The real secret of sanitation is the prompt removal of fæcal matter and refuse from the neighbourhood of inhabited buildings before it has time to decay, as in the early stages of putrefaction emanations are evolved which are highly dangerous to health; it is also an admitted fact that the common fly is a considerable factor in disseminating disease, as it conveys germs on the pads of its feet from infected matter to the food-supply of the inhabitants.

My thanks are due to many who have been good enough to assist me in this work, and especially to Lieutenant-Colonel R. Whitwell and Captain J. C. Vaughan of the Indian Medical Service; to Mr. A. E. Silk, Sanitary Engineer to the Government of Bengal; and to Captain D. Meagher, the Officer in charge of the Government Farm at Allahabad.

G. W. D.

November 1901.

PREFACE TO SECOND EDITION.

THE First Edition of this work was favourably received and, being entirely disposed off within five months of its issue, indicates that a want was met. The Manual has been patronised by the Government of India, the Secretary of State for the Colonies, the Local Governments of Bengal, Madras, Burma, Punjab, the United Provinces of Agra and Oude, Assam, the Central Provinces, the North-West Frontier Provinces, Baluchistan, and other Administrations, as well as by several Native States, and by the Nepal Durbar. A Second Edition with a good deal of additional matter added, has therefore been prepared, but this has been called for before the Author was ready for it, and estimated results have in consequence been given in several instances instead of recorded facts. The science of sanitation is, however, progressing so rapidly, that a good deal of useful information is available, and advantage has been taken of criticisms to amplify several points. Additional information has been given on the Biological System of Disposal of Sewage, on Markets, and Drain Flushing among other subjects, and Appendices C to F have been added.

I take this opportunity of again thanking many who have assisted me, and for the generous tone of the criticisms in the public press.

MUZAFFARPUR,
15th November 1902.

G. W. DISNEY.

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SANITATION
OF
MOFUSSIL BAZAARS.

CHAPTER I.

Surface or Storm-Water Drainage.

Owing to the fact that earth for the construction of most of the huts in a bazaar has been excavated from the immediate vicinity of the buildings, it is a matter of much consideration to determine the most suitable levels the surface drains should start at, as it is of importance that these should be as shallow as circumstances admit of in order that they may obtain the full benefit of purification by sun and air. By adopting as high a level as possible at the head of the drain it enables better gradients, or falls, to be given which aids much in self-cleansing. The greatest care should be taken not to lose, or waste what little fall there is in the plains, as this is simply invaluable. Deep drains rapidly become foul at the sides and bottom, are difficult to flush owing to the quantity of water required to do so effectively, and great temptation is also given to adjacent householders to bridge them over with wide platforms, the consequence being that, sooner or later, the storm-water drain, designed as an open one, and for which it may originally have been more or less suitable, soon changes its character, and becomes a badly designed sewer, which imprisons and concentrates noxious effluvia. When a drain runs beneath a road, provision should be made for a part of it being

easily uncovered to admit of examination and cleaning. All drains should open into others at acute, and not at right angles, and must join at top to top, and not at base level; where necessary the difference of level can be made up by falls.

Surface drainage of small roads.

The surface drainage of small roads and paths in a bazaar is best provided for by the construction of a central drain down the middle, to which the ground is made to slightly slope from each side; this prevents the accumulation of filth in the so-called side drains, which are generally merely long pits; and, provided a slight fall be given, they are self-cleaning at every shower of rain.

In paths or gullies a small concrete saucer drain can be constructed, at a cost not exceeding four annas a lineal foot, into which the house connections can be made,—the paths being paved with bricks, set flat, not costing more than Rs. 2-8 per 100 square feet. These should be laid at a good slope to the drain, and as only foot traffic need be provided for, is amply strong enough. In many cases it will be found that adjacent householders are quite willing to pay for this work, when once a commencement is made, and the advantage is obvious to them.

Kutcha road-side drains.

In kutcha roadside drains care must be taken that, in the process of cleaning, which generally consists in the removal of the bed, they do not in time become permanent roadside trenches without fall; it is much better to have no drains at all than this; mere depressions which, when dry, can be swept, and which will be washed clean after a heavy shower of rain, are much preferable. The proper bed-level of a kutcha drain should be permanently marked by wooden pegs driven well into the earth, and built into a masonry pillar, 1 foot 10 inches square, or by masonry profiles, at intervals of 100 feet apart; this shows at once if the bed-level or section has been unduly lowered during the process of cleaning out.

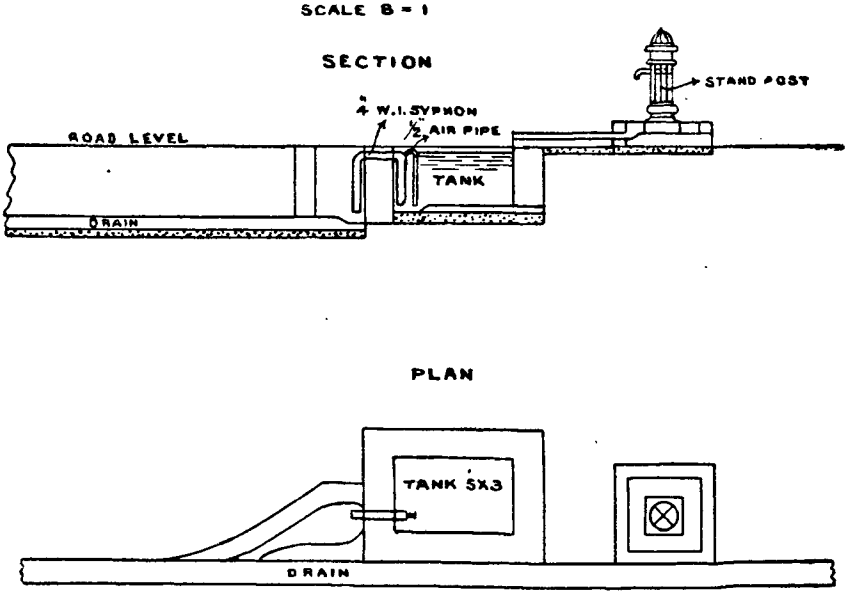
When designing a drainage system for a town it is essential that provision for flushing be made at the same time, otherwise the drains become receptacles for filth for about two-thirds of the year. This can be arranged by the construction of flushing tanks, which, when full automatically discharge into the drains, by water mains laid underground discharging into the head or summits of the drains; and also by the drains being divided up into convenient sections by stops or sluices, which are lifted automatically, or by manual labour, when the section is full of water, thus ensuring an effective flush. Flushing.

A type design of an automatic flushing tank is shown in Fig. 1. These cost about Rs. 100 each complete, the syphon pipe alone representing some Rs. 30. Where sufficient head is not unavailable for this type, Adams' Patent Adamic Flusher may be

FIG. 1

AUTOMATIC FLUSHING TANK

SCALE 8 = 1



suitable. These cost about Rs. 70 for a 4″ pipe size, and works with a head of 10 inches.

Where sullage water is discharged into storm-water drains this should be treated in sullage filters at convenient intervals. *See* Fig. 18, page 36.

Masonry drains.

The most suitable form for surface drains is the semi-circular base, with side slopes of 1 to 2·4, as the discharge is only slightly less than that of the ovoid section, and the drains are more easy to construct. They can be easily swept clean, or run through with a wooden board made to fit the section, and pushed along by a boy.

The Dacca type rectangular drain, as shown in Fig. 2, page 5, is very suitable for narrow lanes. The dimensions can be altered to suit local conditions.

Much useful information as to the preparation of drainage projects, and tables of discharges of different sections, will be found in Practical Instructions in Surface Drainage, by Mr. H. A. Gubbay, Executive Engineer, Public Works Department, published by the Government of Bengal.

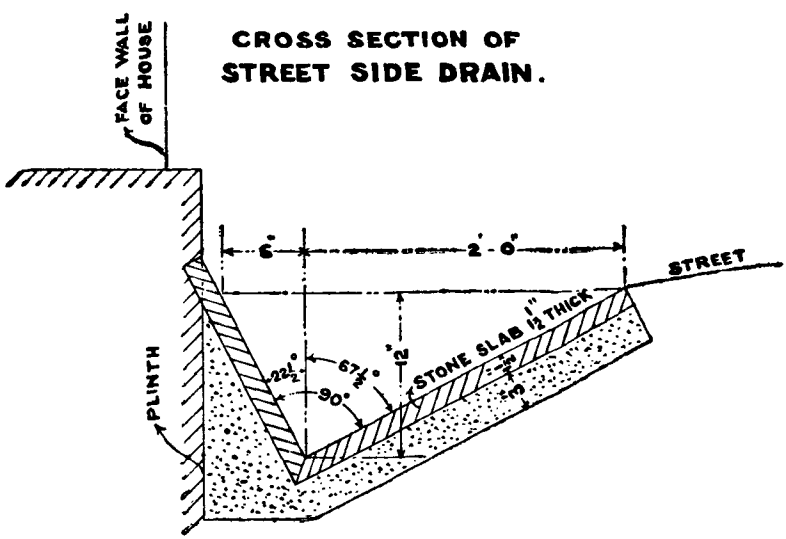
In most cases, when designing a system of drainage, it is advisable merely to take the general surface level of the bazaar as the level to be drained, leaving artificially caused depressions to be filled up with the debris of old buildings, and any available suitable material as opportunity occurs. It is also generally unnecessary to provide for a very heavy rainfall. The usual provision in this part of India is for a run off due to $\frac{1}{2}$ an inch of rainfall per hour from densely built over, and $\frac{1}{4}$th of an inch from suburban areas.

It is more scientific to design the drains with reference to the possible flushing power and facilities available, rather than that of the maximum rainfall.

The importance of proper drainage, especially in connection with checking the spread of malarial fever by anopheles mosquitoes has, owing to recent

researches, been fully recognised. These are found to breed most extensively in the earth-lined drains alongside streets. Where brick-lined, the current should be strong enough to wash away the larvæ, but it is quite otherwise on the numerous kutcha ones in every bazaar. It is also essential, in Bengal, to make use of the powers conferred by the Municipal Act (Section 195) to compel owners to fill up small depressions which, during the rains, form extensive and numerous breeding-grounds. Every attempt should be made each year to brick-line a section of the roadside drains as money is available, where funds do not admit of much being done. Grass and weeds in the earthen drains must be cleared out at regular intervals during the rains, and the oftener the better. Mosquitoes of the culex tribe cannot also be disregarded, as these have been proved to convey elephantiasis to other diseases, and stegomyia, which abound in Lower Bengal, are the hosts of yellow fever.

FIG. 2



CHAPTER II.

Water-Supply from Wells and Tanks.

In order to obtain a comparatively pure water-supply, under circumstances existent in most bazaars, it is essential that the spill water from wells be led away by properly constructed drains beyond what is known as the cone of filtration; this may be described as a circle drawn round the mouth of the well, the radius being equal to the depth of it. Owing to Indian customs, there is always a considerable quantity of spill water in the vicinity of a well, and this, when proper platforms and drains are not constructed, finds its way back, after contamination, by the line of least resistance, either down the sides of the masonry lining, or by cracks and fissures in the ground. For water supplies from wells and tanks the main object is to prevent any water once drawn out, again, after probable contamination, flowing back into the source of supply.

Registering wells.

Arrangements should be made for registering every well in a municipality where this has not already been done, and for taking over, or closing all those the owners refuse, or fail to put in a proper sanitary state. In Bengal this can be enforced under section 200 of the Bengal Municipal Act (1894). A copy of the map of a ward showing the position of all wells and tanks therein is given in Fig. 3. The Well Register, which should be corrected yearly, is given in Appendix C, page 62. It is impossible in most cases, owing to large numbers, for a Municipality to take over, repair, and conserve all the wells (in the town of Muzaffarpur, there were 718 wells) but much good can be done by acquiring a certain number of the most useful unowned ones, and making the owners

MUZAFFARPUR MUNICIPALITY

WARD No. II

SCALE 8 INCHES = 1 MILE

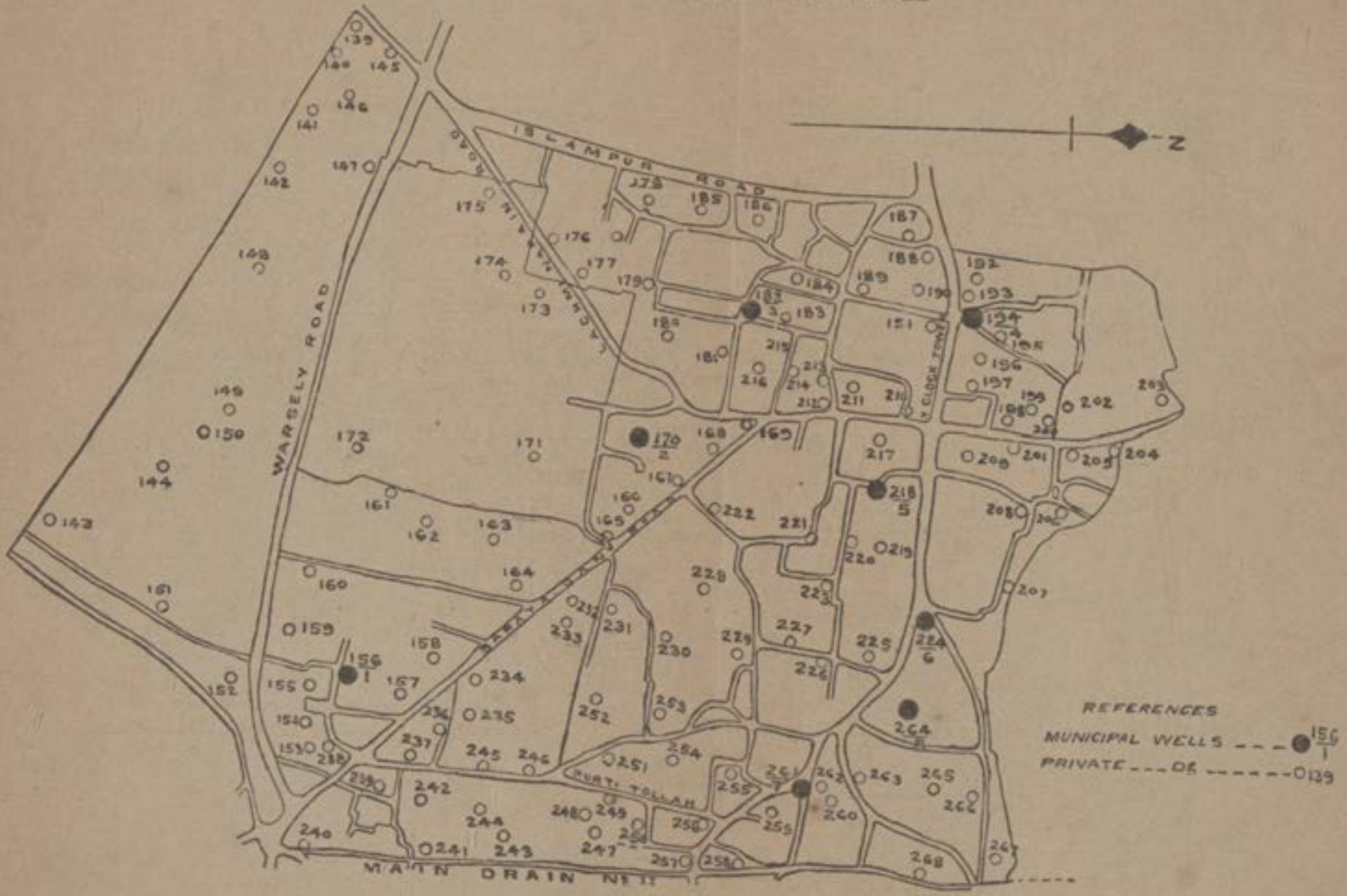


FIG. 3.

of others, when in a position to do so, put and maintain them in a sanitary state. When new wells are sunk, the owner must be made to construct them according to a standard design. Fig. 4 shows an inexpensive and good form of open well, top, and platform. From the experience of ten years in the Muzaffarpur District (from 1891 to 1901), where wells on the sides of main roads were so treated, this is possible. Some 400 wells on 725 miles of road were taken over by the District Board, put in a proper state of repair, suitable platforms and spill-water drains constructed, and arrangements made for annual cleaning out and disinfecting with permanganate of potash during the hot weather months. These were eventually greatly appreciated, and, whereas in the first instance difficulties were experienced in getting hold of suitable ones, it was of late years necessary to make careful selections from the applications received. In addition to this, the owners of numerous ones, on whom notice was served that if they did not put them in a sanitary condition, they would be taken over and repaired by the District Board, elected to do the work on the prescribed lines at their own expense. It is a notable fact that cholera when prevalent in villages close by, frequently is not found in those where these wells are situated. This organization is being extended to villages which have an especially bad sanitary record. For easy reference the Instructions for Repairing, Cleaning and Disinfecting Wells are quoted.

Cleaning and repairing wells.

Repairing.

1. The ground round a well must first be excavated to a depth of at least 5 feet below surface-level, and for a width of 5 feet round the well and sealed with puddled clay, the well lining being first rebuilt from this level where necessary, and continued up for a height of 2 feet 6 inches above ground-level; the top of the well must be sloped off to prevent

vessels being placed on it, and consequent splashing getting back into the well. A properly made platform resting on suitable foundations, must be built round the well at 1 foot above at its highest point, and sloping off to ground-level at its lowest, with a ridge round it to prevent spill-water draining away indiscriminately and an opening at its lowest point, leading into a pucca drain, constructed with a suitable fall, and continued until natural drainage is reached, or outside the cone of filtration, so as to prevent any water lodging in the vicinity of the well.

2. A closed-in top prevents dust, which may convey pathogenic germs, gaining access to the water.

Cleaning.

3. Wells should be dewatered, and cleaned out at least once every year. The sides must be scraped, and all mud, broken earthen vessels, etc., removed; *quicklime* must then be applied to the sides and bottom of the wells.

4. The only suitable time to clean out wells is during the hot weather as the water in them is then at its lowest level.

5. All wells must be cleaned out down to the well-curb or "Jamot."

Disinfecting.

6. Permanganate of potassium is a crystalline salt-like substance of a purple colour, in the preparation of which only mineral substances are employed.

7. Put one or two ounces of the solid substance into a *dol*, or bucket, which has been filled with water drawn from the well about to be treated. Stir it up, and pour the red solution thus produced into the well, leaving the portion of permanganate that is

Fig. 4.
Well Top
Scale 16'—1"

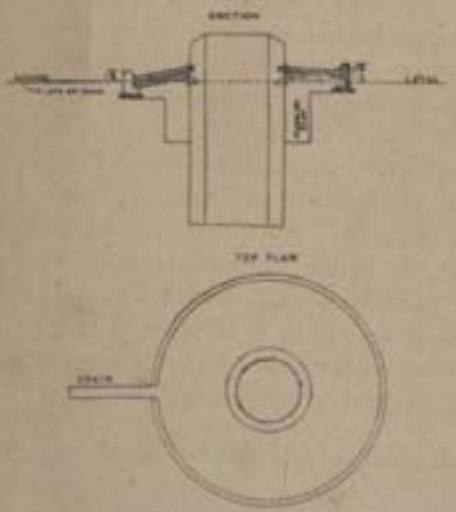


Fig. 5.
Scale 16'—1"

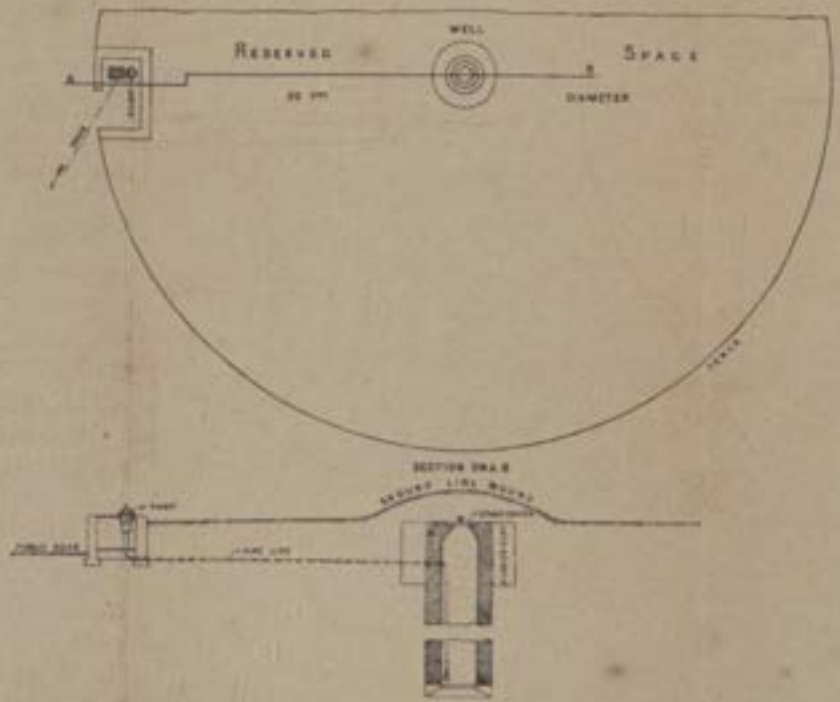
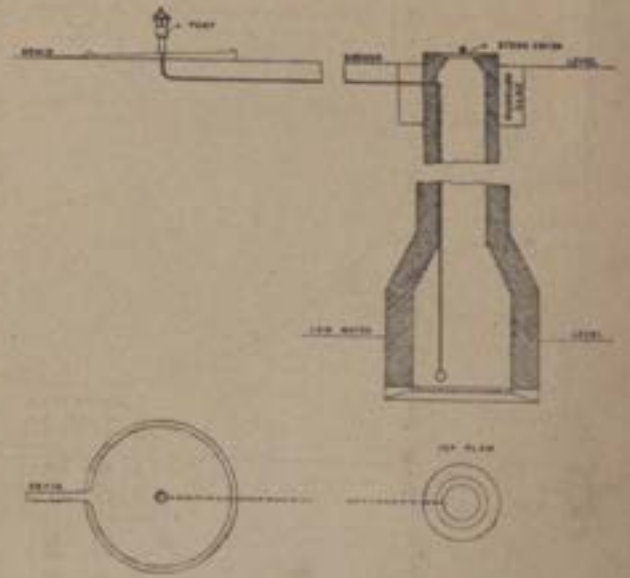


Fig. 6.
Scale 16'—1"



not yet dissolved at the bottom of the *dol*. Lower the *dol* into the well, fill it with water, draw it up, pour back the water as before, and repeat the process till all the permanganate has been dissolved. In all cases enough permanganate should be added to produce a faint red colour lasting for 24 hours.

8. If the water in the well is bad, more permanganate will be necessary. In such a case it will be found that the strong red colour at first produced quickly changes to brown, and then fades away. This is because the permanganate destroys dirt and is destroyed by it. Therefore, if the water in the well is clean, a smaller quantity of permanganate will be necessary. From one to four ounces of permanganate will be found to be enough for ordinary wells. If more permanganate is added than is enough to produce a faint permanent red colour, it is likely that frogs, that may be in the well, will be killed. This will, in a few days, give the water a putrid taste. If the quantity of permanganate is not enough to produce a faint permanent red colour, it is unlikely to do good. If possible, the permanganate should be added at night, in order to leave the wells undisturbed as long as possible. The water will be fit to drink on the following morning. If then a red colour is still present, the water may have an unpleasant taste, but it is perfectly harmless.

Figure 4 is an illustration of the latest pattern of well adopted.

New Wells.

When a new well is proposed, and local conditions are suitable, a safe form is that designed by Dr. Cameron of Wigton, N. B. This arrangement is shown in Fig. 5. The well should be in the centre of a reserved area of at least 20 yards in diameter, and the lead pipe leading from it to the pump must be fitted by brass screw joinings. This is a suitable design for the vicinity of cutcherries, where an open space for a reserved area is generally available.

Another excellent design for a new well, and one more generally suitable, is shown in Fig. 6. This prevents any danger of the water being contaminated by dirty vessels being lowered into it for the purpose of drawing water.

Tube Wells.

Tube wells answer admirably in many localities ; it is, however, always essential to have a bore hole made first to determine the stratum which has to be tapped, as the point of the tube may be easily driven through this. An improved form of pump is shown in Fig. 7 ; this obviates the danger of impure water being put in the mouth of the pitcher spout pump in order to make it draw.

FIG. 7.

The great advantage of tube wells is that they enable a stratum, underlying that of impermeable stiff clay which exists in many cases, to be tapped, thus avoiding the danger of contamination by subsoil water. The supply from a tube well is, however, limited in quantity.

Where wells are founded on a clay stratum their efficiency can generally be largely increased at a trifling cost, by driving a pipe lined boring down until water-borne sand is met. Great care must, however, be taken that, when the boring is going on, this stratum be not passed through, and constant tests of the discharge obtained at the various depths are therefore necessary.

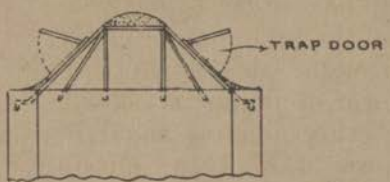
Water drawing utensils.

In all cases it is advisable either to provide a pump on a public well, or iron buckets with light chains and wooden pullies, so that private water drawing vessels be not lowered into the water. The pump should be fixed on the platform surrounding the well, and not on the top. A light corrugated iron roof over the mouth of a well is also useful in pre-

PLAN OF DOME FOR WELL

SCALE 8FT = 1 INCH

SECTION ON A B



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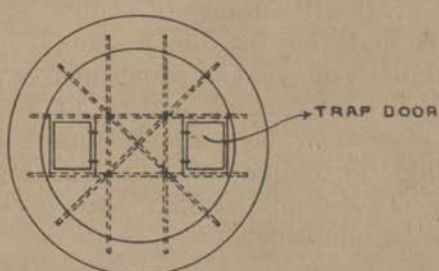


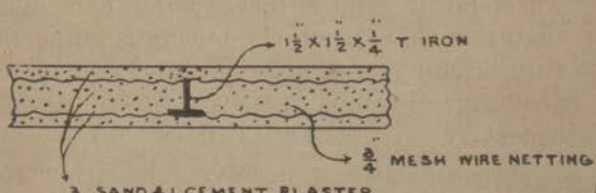


FIG. 8.

venting leaves, and other impurities falling in, and also in affording shelter to the water-drawers.

An effective and economical well cover designed for Ranchi is shown in Fig. 8, page 11. This, for a 8′ diameter well, costs about Rs. 90.

Tanks.

A large proportion of the water-supply of a Municipality is usually taken from tanks, into most of which the drainage water from the neighbouring vicinity is washed during the rainy season. This can be prevented by raising the banks. The sullage water of a bazaar is indescribably filthy, and if in-drainage is prevented the tanks will fill up by percolation as the level of the subsoil water rises—a bad enough source of supply, but infinitely purer than the surface water combined with filth from a crowded area. The excavation of new tanks in a Municipality should be discouraged as much as possible, and attention paid to conserving the existing ones. Small pumps and masonry platforms for washing purposes draining away from the tanks will improve matters. In the late Mr. A. E. Silk's book on "Municipal Engineering in Bengal" the following classification of comparative purity of water-supply is adopted :—

1. Deep spring water.
2. Subterranean or deep well water.
3. Upland surface water.
4. Subsoil water. (If distant from any collection of houses).
5. Land springs.
6. River water.
7. Surface water from cultivated land.
8. Subsoil water under villages or towns. Surface water from a bazaar is classified as sullage.

Where tanks are used as a source of drinking water-supply, they should be properly fenced and conserved, and the water drawn by a pump. Recent researches have proved that polluted water, if stored

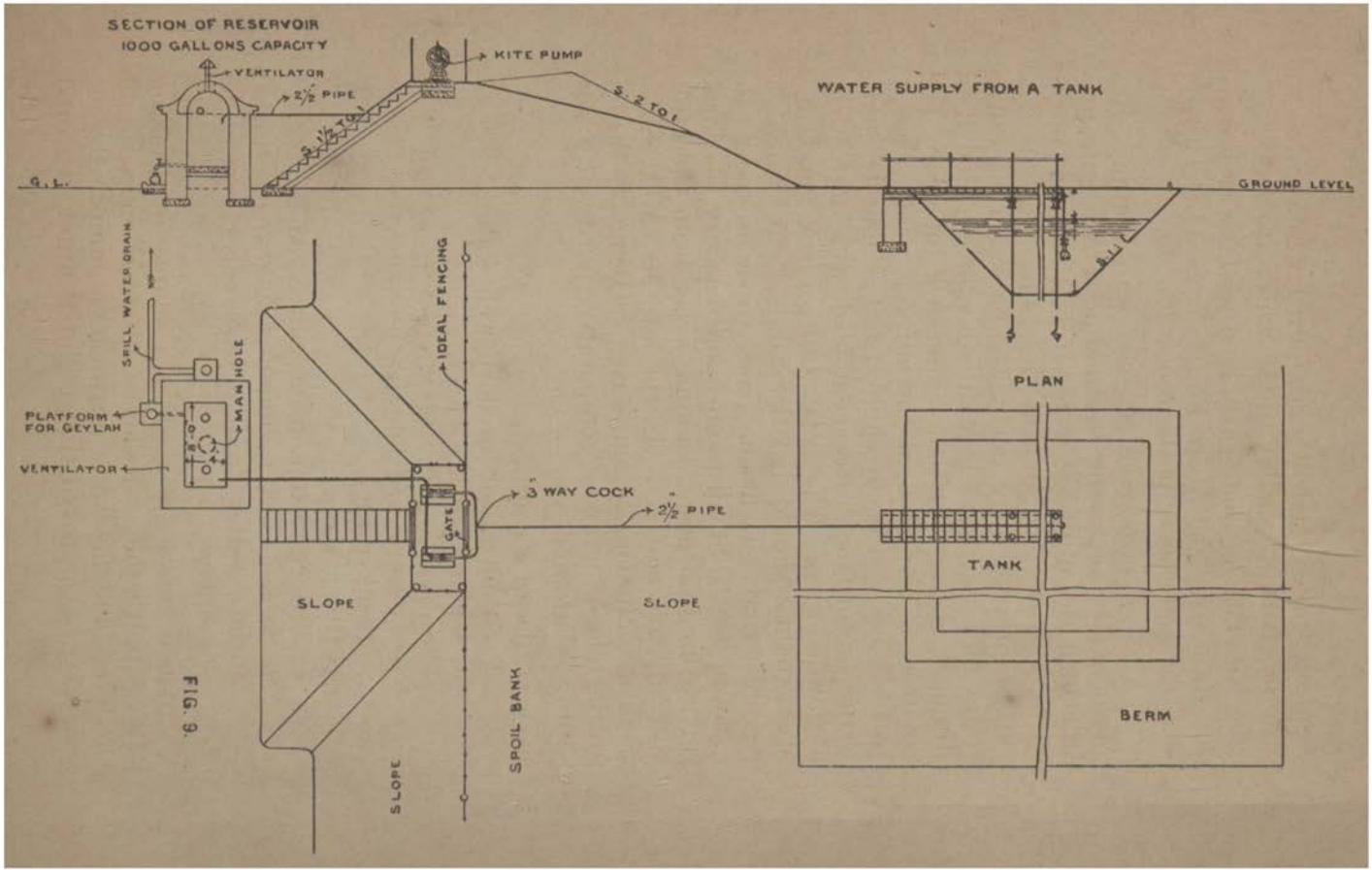

SECTION OF RESERVOIR
1000 GALLONS CAPACITY
VENTILATOR
2½" PIPE
KITE PUMP
S.2 TO 1
G.L.
WATER SUPPLY FROM A TANK
GROUND LEVEL
SPILL WATER GRAIN
MAN HOLE
IDEAL FENCING
PLATFORM FOR GEYLAH
VENTILATOR
3" WAY COCK
2½" PIPE
GATE
SLOPE
SLOPE
SLOPE
SPOIL BANK
PLAN
TANK
BERM

FIG. 6.

in a tank or reservoir where it can be preserved from subsequent contamination, rapidly becomes pure. The Type plan, approved by the Sanitary Board of Behar and Orissa, is shown in Fig. 9, page 13. This for an existing tank of 100 yards square area is estimated to cost Rs. 2,700. The pumps, provided in duplicate, are Kite double action pattern and cost about Rs. 425 each. The fencing provided is the Ideal Woven wire fence, 10 strands, 48″ high, and can be fixed at about 12 annas per yard.

Another and a cheaper method is shown in Fig. 10, page 15. Here the tank is completely fenced in with the exception of an entrance to a platform which extends towards the centre of the tank from which the water can be drawn by hand. Model rules for clearing out and re-excavating tanks are as follows :—

Excavation.

1. Tanks should be cleared out and re-excavated during the dry weather months when the level of the subsoil water is at its lowest. Work should be commenced in January or February and completed before the middle of May, but these dates must depend more or less on the locality, as in some parts of the Province the prevalence of heavy thunderstorms in May might make it advisable to complete the work before then.

2. The re-excavation, until water-level is reached, should be carried out in regular layers of 1 foot in depth, an offset of 1 foot being left on the bank side for each layer. This, when dressed off, will give a regular side slope of 1 to 1 to the tank. When water-level is reached, if it be considered necessary to excavate below this, and if pumping machinery to dewater the tank is unavailable, the area must be divided up into compartments of suitable size, separated by bunds, one, or more of which, can be dewatered by bailing into the adjacent ones, when the excavation can be continued to the required depth, the other compartments being similarly treated in turn.

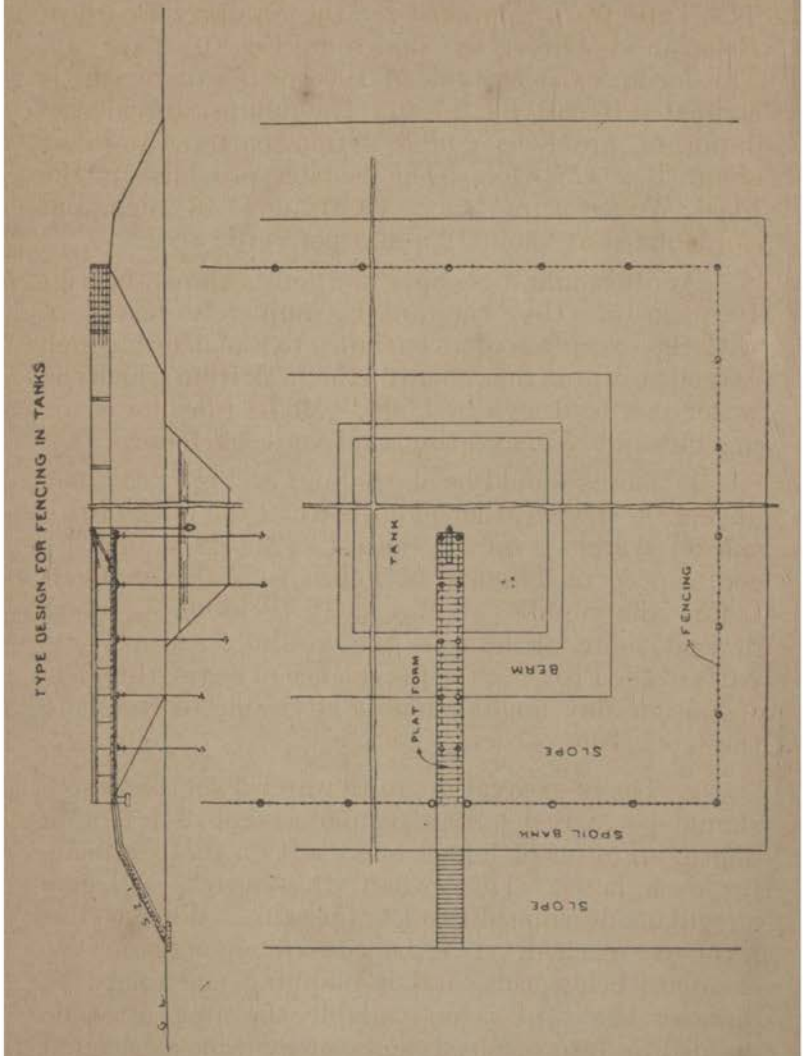

TYPE DESIGN FOR FENCING IN TANKS
TANK
BERM
PLAT FORM
SLOPE
FENCING
SPOIL BANK
SLOPE

FIG. 10.

Disposal of Spoil.

3. The spoil from the excavations should be placed on the outside of the embankment formed round the tank when originally made, and should be deposited in such a position to preclude, as far as possible, its being washed back again by rain water.

Dressing and Turfing.

The crest of the embankment should be dressed off to a slope of 1 in 12 away from the tank, with side slopes on the outside of 2 to 1. This will prevent direct contamination of the tank by spill water from the crest, where persons or carts, may have encamped.

All slopes should be neatly dressed off ; all those above highest water-level being turfed during the commencement of the ensuing rainy season. This is very important as it prevents the chance of a considerable quantity of the excavated earth being washed back into the tank.

Water-supply for Municipal and Rural areas is a subject which is, at the present day, receiving much attention. It is being encouraged by contributions from Government and from Local Authorities, by gifts from wealthy Indian gentlemen, and by loans from Government redeemable in a fixed period. For rules for the preparation of projects in the Province of Behar and Orissa see Appendix F, page 69, and for the table of instalments for the repayment of loans, Appendix E, page 68. The comparative death-rate from Cholera and Intestinal diseases in Municipalities which possess a pipe water-supply, and those without, need only be glanced at to prove the vital importance of a pure water-supply, and even these figures do not adequately indicate the true position, as further loss of life due to water-borne diseases, cannot be traced out from the statistics published. Major S. A. Harris, I.M.S., Sanitary Commissioner, United Provinces, in his paper on the effect of a pipe water-supply on the reduction of Cholera in urban areas, read at the Second All-India Sanitary Conference at Madras, in November 1912, quotes the reduction of death-rate per mille before

and after the provision of a pipe water-supply for the following places :—

	Before.	After.
Dehra Dun	10·19	2·25
Meerut	7·49	3·02
Naini Tâl	10·19	2·86

and stated that the number of years in which the Cholera death-rate rose above 1 per mille is seen to have been reduced by the filtered water-supply to about $\frac{1}{3}$ in Dehra Dun, Meerut, Benares, Lucknow and Naini Tâl.

The cost of Water Works must vary considerably according to local conditions. Where the supply is derived from a source not liable to contamination, from spring wells, tube wells and infiltration galleries, where subsequent filtration is unnecessary, the capital expenditure may vary from Rs. 3 per head for a tube well, Rs. 4-8 from an infiltration gallery supply, such as Congeeveram (Madras), to Rs. 10 and over for a filtered water-supply derived from a river. The cost of the distribution system must necessarily vary according to its size, and the density of population in the area served, but this, under normal circumstances, may be assumed at 50 per cent. of that of the Water Works. As each Province in India has a Sanitary Engineer, and as the subject of the preparation of a Water Works project is a highly technical one, it is beyond the scope of this work to go further than to impress its importance. Any efficient Water Works started means a large saving of human life and of much misery.

CHAPTER III.

Road Making.

One of the most important points towards obtaining a good metalled road is to ensure a proper foundation for the metal to be consolidated on, and to see that the sides are well confined or tied in. Where bricks are used for this foundation they should be whole ones, not bats, be tightly packed together and then rammed with a wooden rammer. The edging should consist of bricks-on-end well backed up with earth on the out, or berm side. The same applies where stone is used for the soling. These must have flat surfaces, be of fair size, and be well hand-packed together and rammed. It is not much use doing metalling work on a raised road until the embankment has at least 2 rains over it to properly consolidate it. This equally applies to the approaches to bridges on a kutcha road where the metalled portion should be extended to a length of at least 10 feet beyond the toe of the approach slope.

Stone Metal.

In most municipalities it is financially impossible to thoroughly repair all the roads each year, nor is it necessary to do so, if the work has been properly done. A system of biennial or triennial repairs should therefore be evolved. A diagram showing how this can be arranged is shown in Fig. 11, page 19.

In the selection of stone metal it is of great importance to see that stone of equal grade and hardness is used, and that surface, or weathered rock, is not mixed up with the harder material lying underneath it in the quarries. The stone should be broken to the size that the largest piece shall pass

freely through a $1\frac{1}{2}$" diameter ring. When repairing existing metalled roads it is essential that all old

DIAGRAM

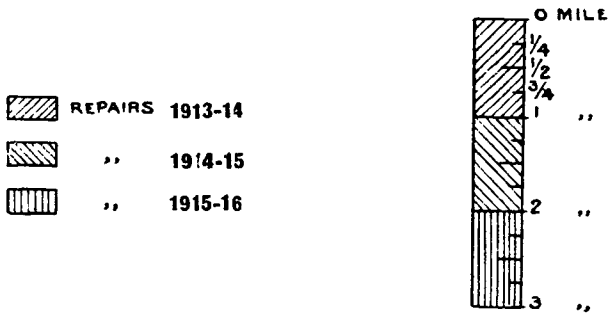


FIG. 11.

metal be picked up, and any rounded, or traffic-worn portions re-broken, as it is impossible to ensure good consolidation unless the edges and corners of the stone metal be sharp. Consolidation should be done by a heavy roller. A steam roller for preference. The cost of a 6-ton steam roller is about Rs. 6,000 and the working cost about Rs. 4 per day, but this must necessarily vary considerably in different localities, depending on the cost of fuel and labour.

For Oiling Roads.

Oiling Roads.

The roadway must first be swept clear of dust and foreign material, when the mixture composed of one part of coal-tar to 20 parts of oil (liquid fuel), mixed cold, must be sprinkled on through a watering cart. Men with hard long handled brushes follow the cart, and brush the mixture into the roadway, and repeat this operation for the second time in the reverse direction, when $\frac{1}{4}$ of a mile has been done. The oiling lasts for about 2 months, and costs about Re. 1 per hundred square feet.

Tar-Macadam.

Although tar-Macadam may be somewhat ambitious for mofussil municipalities, an abstract of the specification for MacCabe's tar-Macadam, which was kindly supplied to me by the Chief Engineer of the Calcutta Corporation, is of interest, see specification Appendix H, page 75. The cost of a road so laid is Rs. 2-2-0 per square yard, and although sufficient experience is not available to predict its life, some has been down for 3 years and is still good. The materials consist of two parts Pakoor Stone metal, MacCabe's patent Bituminous binder of Gas Co.'s Coal-tar, and Stagg brand English coal-pitch, in the proportion of 1 of tar to 3 of pitch by weight, with stone chipping, and sand as a top binder.

Kunkar Metal.

All *kunkar* metal required for metalling or repair work should be collected, screened, and stacked by the middle of May at latest; screening must be done in the dry weather, otherwise the meshes of the screen soon clog up when the *kunkar* is damp, and the operation is more or less a farce. A specification for this is given below :—

(1) All *kunkar* must be washed, cleaned, and screened during the dry weather months; and must be of such quality that, being re-washed and re-screened through an expanded metal screen of $\frac{3}{8}''$ mesh, set at an angle of 45°, shall leave a residue of 80 per cent. pure *kunkar*. If *kunkar* of a lower standard is stacked it must either be rejected, or the cost of bringing the metal up to specification, deducted from the price paid.

(2) No *kunkar* should be measured after the 1st June. All *kunkar* collection must be completed by 15th May.

Brick Metal.

Brick metalled roads are rarely successful owing to the difficulty of ensuring that the metal is of equal hardness throughout, and especially so in a dry climate, as under heavy traffic the metal soon wears into brick dust, which either blows away in the dry season in the form of dust, or is washed away in the rains; on no account should *jhama*, or vitri-

fied brick, and red brick metal be mixed, as their degree of hardness is so different.

Morhum & Kutcha Roads.

It is of great importance that excessive slope be not given in morhum or kutcha roads, otherwise they will rapidly gutter during heavy rain. A rise of 1 in 50 to the centre of the road will generally be found to be ample.

Stacking Metal.

In order to control the collection of material it is essential that all be stacked to gauge, or in boxes, and that the stacks be of equal size, thus facilitating measurements.

Consolidation of Metal.

Consolidation of metal must invariably be done as soon after the rainy season sets in as possible, and especially so for *kunkar*. Any heavy rainfall in a water-bound road after the metal is once laid is invaluable in helping consolidation, as it fills up all the interstices which may be left after rolling or ramming; *kunkar* should be consolidated by ramming with heavy wooden rammers, although on a new road a roller will be of use in forcing the *kunkar* in between the joints of the soling bricks, and jamming them into the earth, thus making a solid foundation. A plentiful supply of water should be used in the process of consolidation; this is most essential. Stone and brick metalling should be consolidated by heavy rollers, a minimum quantity of surfacing material being used. It is of great importance to keep the berms well made up against the metalled portion of a road, otherwise the metal will rapidly spread out under traffic.

In all cases it is of the greatest importance that the natural aid afforded by climatic conditions be utilised in making roads; this is a subject the importance of which is frequently overlooked. When the consolidation of metal is seen to be going on after the end of the rains, unless there are exceptional circumstances to justify this, the official in charge may be condemned at sight as being ignorant or incompetent.

Long lengths of road should not be taken up for repairs at a time, as this causes much inconvenience to traffic. A furlong is the uttermost limit admissible.

CHAPTER IV.

Building Construction.

Materials Kunkar Lime.

Kunkar lime should be burnt near the site of works from clean *kunkar* with coal or charcoal. When the burnt *kunkar* is taken out of the kiln it must not be slaked, but after any clinker has been removed, should be ground fine enough to pass through a screen of 400 meshes to the square inch, and must be used freshly ground. It should contain over 40 per cent. of Oxide of Calcium.

Stone Lime

Stone lime should be obtained unslaked. Before being used it must be slaked and sifted through a screen of 400 meshes to the square inch.

Lime Mortar.

Lime mortar to consist of fresh lime mixed by measure with sand or *soorki* in one of the following proportions, as may be directed:—

(*a*) 1 *Kunkar* lime.
2 *Soorki.*

(*b*) 1 *Kunkar* lime.
1 *Soorki.*
1 Sand.

(*c*) 1 *Kunkar* lime.
2 Sand.

(*d*) 1 Stone lime.
2 *Soorki.*
2 Sand.

(*e*) 1 Stone lime.
3 *Soorki.*
1 Sand.

(*f*) 1 Stone lime.
4 Soorki.

(*g*) should not be used in the dry season as it sets too quickly.

The materials should be spread in layers not exceeding 3 inches in thickness, and then incorporated in a steam mortar mill, or bylechuki, with sufficient water to make it into a stiff paste. Mortar which has once commenced to set should on no account be used in any work.

Kunkar or Hydraulic lime must invariably be used for water-works and for wet foundations.

Soorki must be made from well burnt brick-bats, and must pass through a sieve of $\frac{1}{16} \times \frac{1}{16}$ mesh. Freshly burnt bats must only be used. **Soorki.**

Sand must be clean, sharp, and free from dirt. **Sand.**

Khoa must be broken from thoroughly burnt bricks to pass through a ring of $1\frac{1}{2}$" diameter. **Khoa.**

Portland cement must be of the best quality of English manufacture and comply with the standard tests. **Cement.**

Cement plaster to be made of one part of Portland cement to two parts of sand, and must be properly mixed and applied fresh, the thickness of each layer to be $\frac{1}{2}$" finished. The surface must be kept covered with wet bags or straw for at least three days, after it has been completed. **Cement Plaster.**

Bricks must be hard, well-burnt, sound, true to shape and size, and free from flaws and other imperfections, and to be of approved sample. **Bricks.**

Bricks must be laid true to line and level, with joints not exceeding $\frac{3}{8}$" in thickness, and of approved bond. They must be soaked in water for at least four hours before being used. All joints must be raked out to a depth of $\frac{1}{2}$", while the mortar is fresh. **Brick Work.**

All joints to be at least $\frac{1}{2}$" in depth, and thoroughly cleaned out by watering and rubbing with a brush. Mortar for pointing to be composed of one part of lime and one part of *soorki*, ground very fine in a mill, or strained through coarse cloth. Flush **Pointing.**

pointing to be lined off true horizontally and vertically with a string, the lines thus made to be deepened by a rule made for the purpose.

Culverts.

The type of culverts adopted must be dependent on the depth of the drain below the surface of the road. Where arching can be done it is preferable. Where impracticable, the top should be covered with stone slabs. Parapets should be provided with stone copings. All culverts on a road or street should be numbered, and registered in the form given in Appendix G, page 74.

The system of quadrennial repairs to bridges and culverts is an essential towards efficient administration, and when once successfully introduced, is economical.

In masonry buildings a damp-proof course, which may be made with either asphalte, or with a layer of Portland cement 1″ in thickness, laid at the top of the plinth, and just above floor-level, is most desirable in order to prevent damp rising in the walls, if for no other reason than that it prevents damage to the masonry, and to the plastering, or pointing.

CHAPTER V.

Latrines and Urinals.

In dealing with the sanitation of a bazaar, the provision of scientifically designed latrines and urinals is a matter of the greatest importance. There are numerous patterns of these, some very well arranged as regards the necessary requirements for efficient working, but many more not so. The selection of the pattern adopted is frequently a mere matter of chance, and the attention paid to the subject by the Municipal Commissioners a minimum quantity; badly arranged ones are probably just as expensive to construct in the first instance as good ones, which are much more useful.

Distribution of Latrines and Urinals.

A large number of small latrines and urinals suitably distributed are more effective than a few large ones, and are not much more costly to construct and maintain; they should not be grouped together, or placed back to back, as light and air should be allowed to play on all sides; for convenience a small covered annexe may be provided for the carts. For ventilation purposes it must be remembered that, owing to the friction of the air on the sides, a number of small openings are not nearly of as great value as a large one of the same area. Where good drainage is unavailable, storm-water from the roofs should discharge into moveable buckets which can be easily emptied, thus avoiding saturation of the soil. Care must however be taken to put these in places where they cannot be misused.

Ventilation.

Drainage.

Latrines at Police Barracks and private houses.

Latrines should be provided at all Police barracks or out-posts; the prevention of nuisance in a Municipality is under the control of the local police, and the out-posts are, in many cases, either unprovided

with latrines, or have them of such a description that the men are driven to commit the nuisance they are supposed to prevent. Similarly, house-owners should be made to provide suitable arrangements for their servants.

Bailey's Patent Latrines.

A good latrine in the Indian market is 'Bailey's Patent,' Fig. 12. page 27. This combines efficient ventilation of the latrine, with an arrangement of double trays, thus preventing saturation and consequent pollution of the soil on which it stands. The superstructure is made of corrugated iron strongly braced, and can be made of any number of compartments required; the patent latrine seat inside is independent of the superstructure, and can be easily taken out and cleaned. The seats however are inconveniently small. They cost from Rs. 114 for a two-seat to Rs. 324 for an eight-seat one.

Donaldson's Separation Latrine.

Donaldson's Separation Latrine, in which the urine and solid matter are kept separate, is also an excellent pattern. Separation latrines are, however, unsuitable where it is proposed to deal with the night-soil by bacteriological agency, and must seriously decrease its manurial value also. It is merely a handy way of disposing of solid fæces.

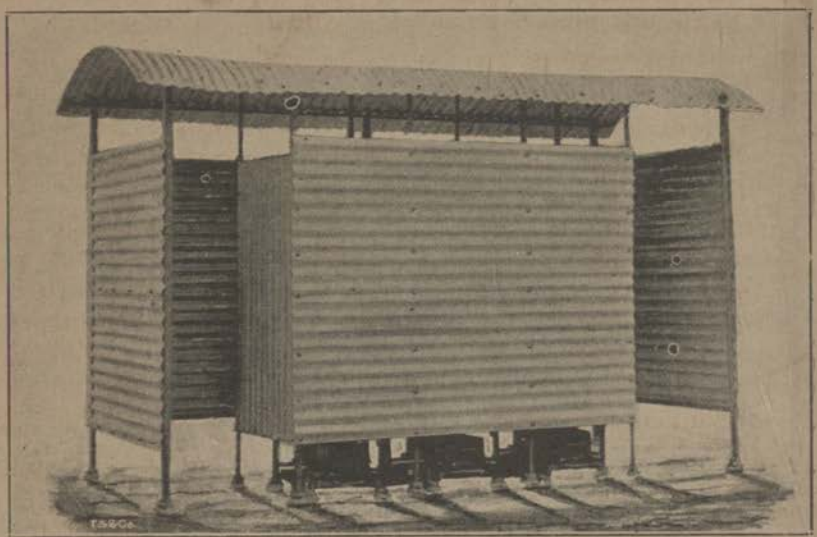
Alipore Pattern Latrine.

The Alipore pattern latrine is a good type. Stoneware seats set in brick-work are preferable to iron ones.

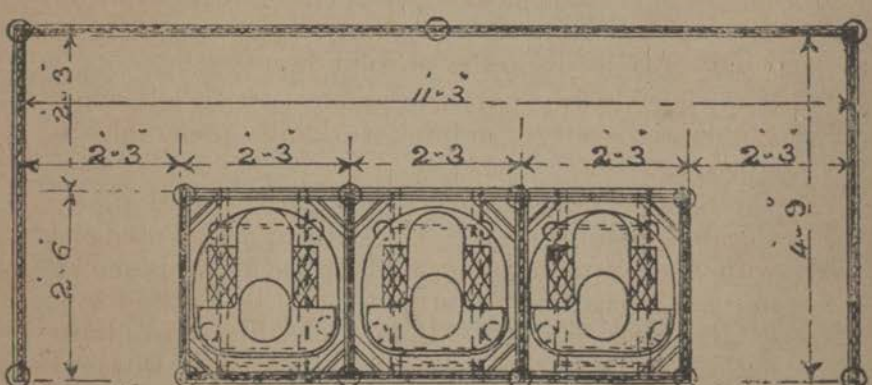
Septic tank latrines are very useful under suitable circumstances. A design for a 12-seated one with a separate flushing tank for each seat is shown in Fig. 13, page 28. the estimated cost being Rs. 4.586, or Rs. 382 per seat. Before deciding on adopting a latrine of this description, "Sewage Disposal in the Tropics," by Major Clemesha, I.M.S., Sanitary Commissioner, Bengal, should be consulted.

Masonry Latrines.

Where masonry latrines or urinals are provided, the walls and floor should be smooth and well polished to allow of easy cleaning, and should be white or some light colour, so that if there is dirt, it can be at



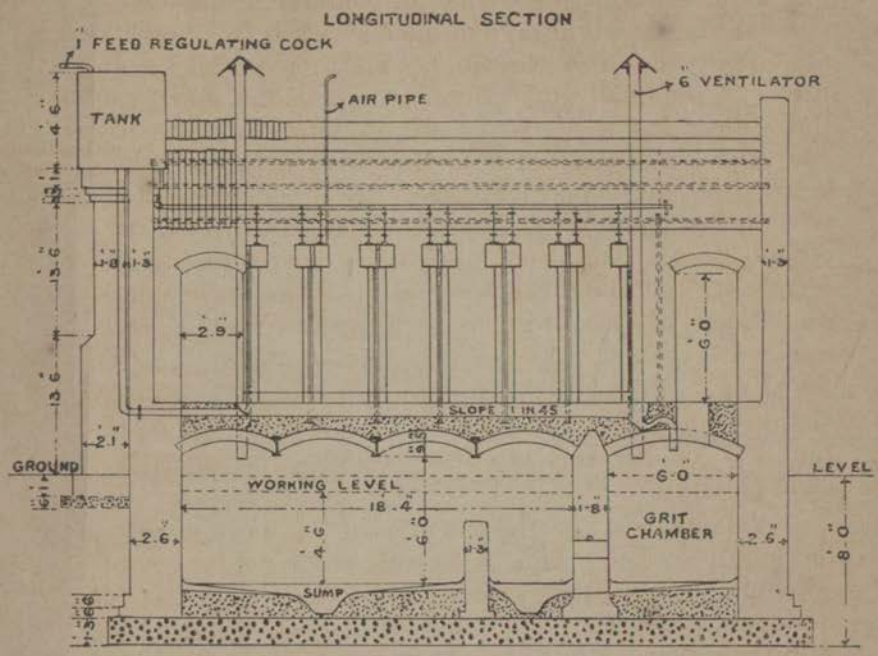
Plan.



BAILEY'S PATENT LATRINES, WITH SUPERSTRUCTURE "STANDARD PATTERN."

FIG. 12.

PLAN OF 12 SEATED SEPTIC TANK LATRINE



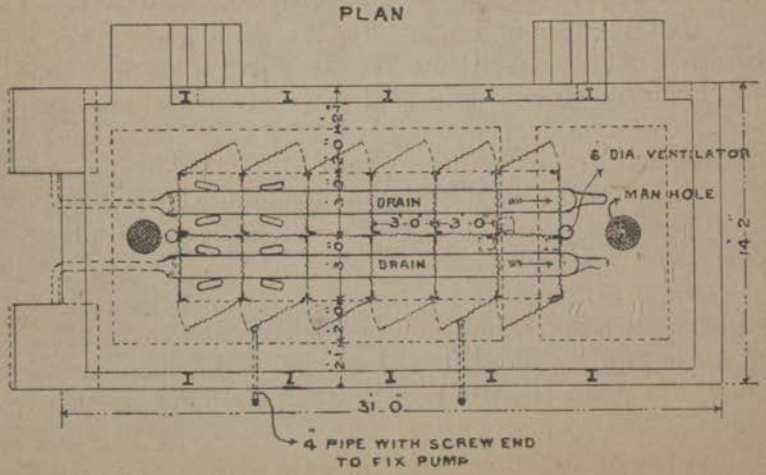


FIG. 13.

once seen and removed. In latrines for hospitals, and also in public ones which are much frequented, it would be an advantage to line the walls to a height of 3 feet, and also the floors, with glazed tiles or bricks. This will make them much cleaner and less forbidding looking. It is an obvious mistake to coat the lower part of a latrine wall with tar, the antiseptic value of which, especially in a hot climate, is soon lost, and which hides and retains dirt in its composition. The usual practice is to cover a dirty latrine wall with a fresh layer of tar, thus preserving an old coat of filth and forming a fresh bed for a new one.

Disadvantages of Tarring.

In all latrines it is of great importance to have the rear openings of convenient size for the efficient removal of the buckets from their seats on the level platform.

A cart urinal in the vicinity of cutcherries will be found useful. This is merely a receptacle of convenient size resting on a masonry floor and placed under a raised and enclosed platform on which the squatting plate is fixed ; the receptacle can be easily removed and replaced by an empty one ; the form is a convenient one and can be efficiently ventilated.

Urinals

Bailey's Patent Urinal, Fig. 14, page 30, is very suitable. This costs from Rs. 48 for a two-seat to Rs. 222 for a six-seat one. The patent urinal stands inside the compartment and can be taken out and cleaned without difficulty. For disinfecting purposes chlorinated lime is very useful. It should have 33 % of free chlorine, and must be used fresh as it rapidly decomposes. Phenyle is also very useful.

Hindu Patent Urinal.

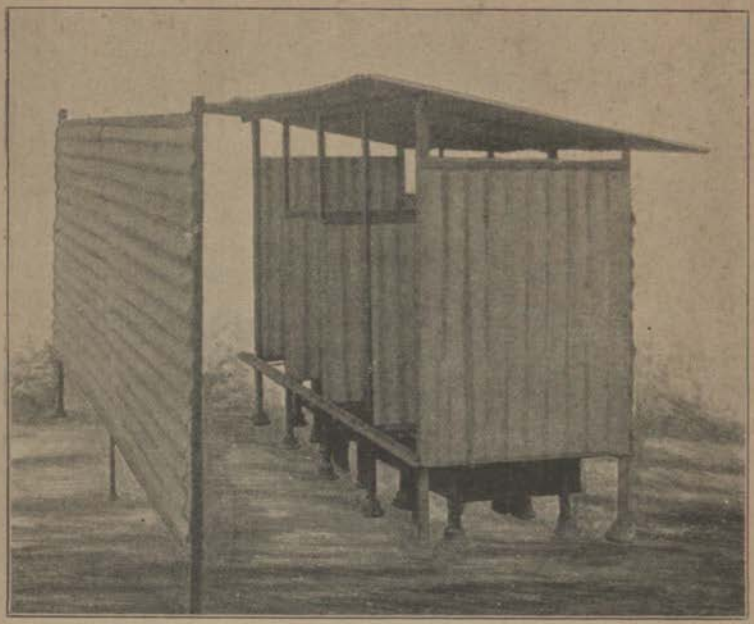
Disinfectants.

An ingenious way of making Hindus face the right way, when using latrines, is to make the mark of an outspread hand in red on the wall which they should face, as no Hindu will turn his back on this sign.

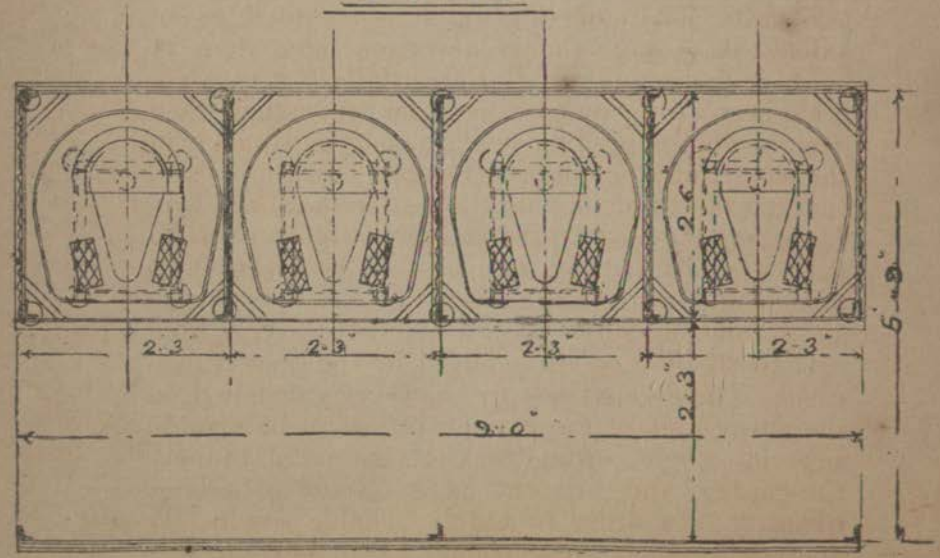
Red Hand Marks.

A set of model rules for private privies and urinals is given in Appendix A, page 57.

Model Rules



Plan.



"HINDU" PATENT URINAL, WITH CORRUGATED IRON SUPERSTRUCTURE.

FIG. 14.

CHAPTER VI.

Collection and Removal of Night-Soil.

In mofussil towns in Bengal the night-soil is generally collected from public and private latrines by conservancy carts drawn by bullocks, and varying in capacity from 60 to 200 gallons. These, as a rule, begin work early in the morning so as to avoid causing a nuisance in the thoroughfares, travel at a very low rate of speed, not over 2 miles an hour, and only make one trip a day, in the majority of cases, owing to the distance the trenching-grounds are away from the centre of the town. This means that a large proportion of the human excreta remains at least 24 hours in the receptacles of the latrines in the immediate vicinity of densely populated localities. In the temperate climate of England it is accepted as an axiom that sewage should never be more than 24 hours in finding its way to the outfall, as it is, when it has begun to decompose, more dangerous than when fresh and decomposition sets in much more quickly in the semi-tropical climate of Bengal. In many cases the quantity of night-soil collected per head per diem is exceedingly small; the average amount of solid matter evacuated by natives may be taken at 10 ounces, and of urine 30 ounces, whereas returns from several municipalities show a quantity varying from ·047 to ·37 of a gallon removed by the conservancy carts. These quantities are, however, calculated on the entire area of the municipalities, including the suburbs, where, owing to the custom of Indians, the gardens and adjacent fields dispose of a large quantity. In order to obtain reliable results, the densely crowded areas should be divided up into

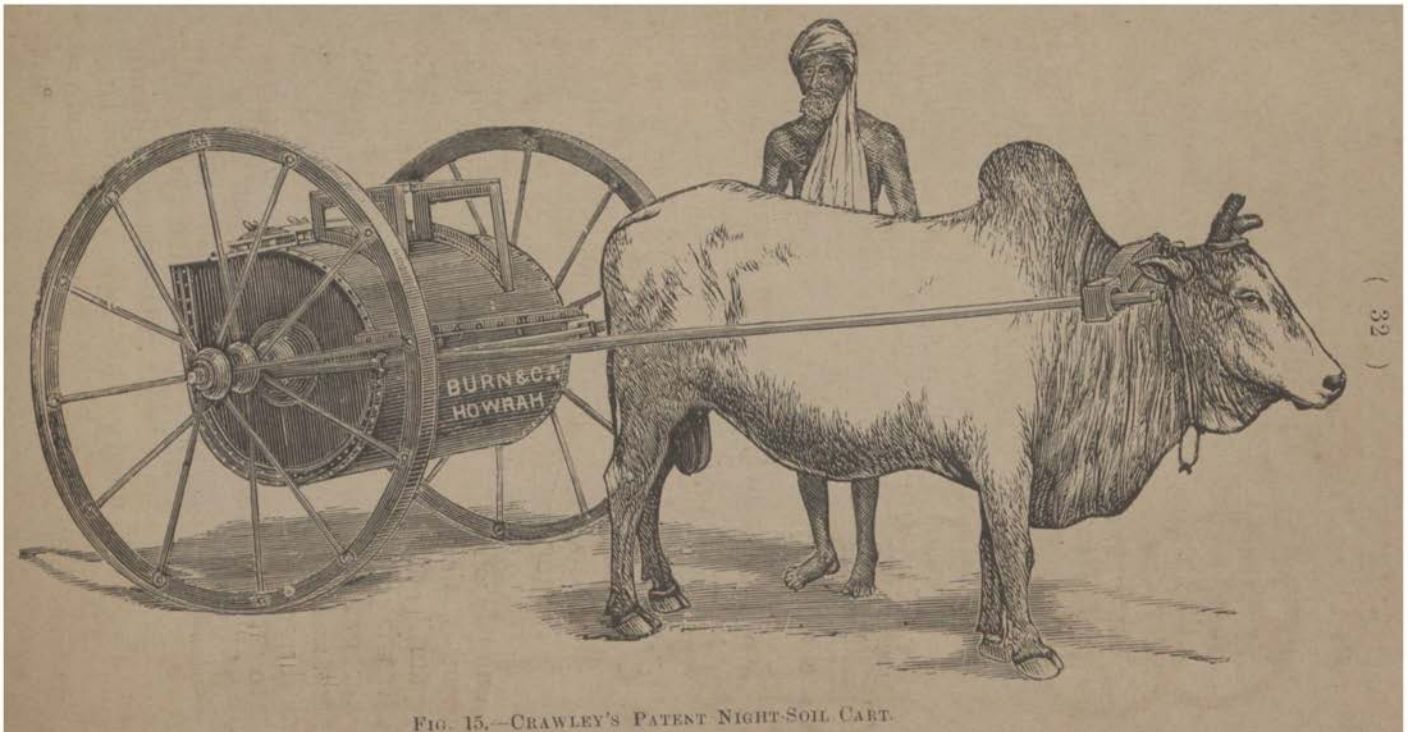


FIG. 15.—CRAWLEY'S PATENT NIGHT-SOIL CART.

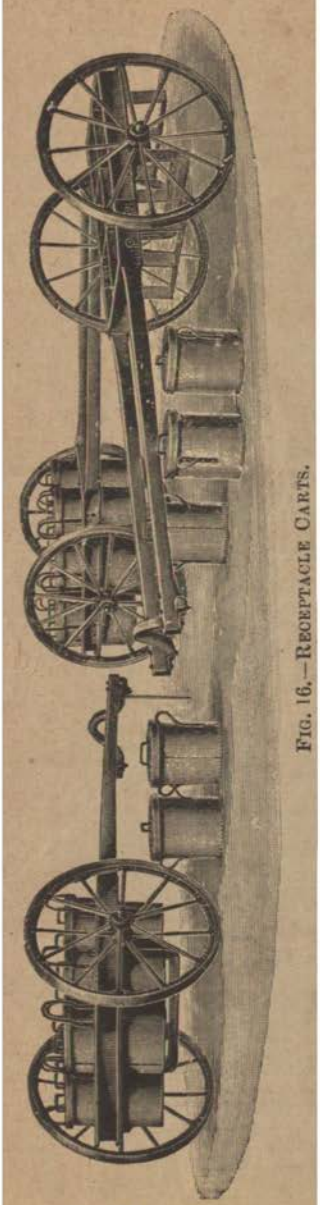


FIG. 16.—RECEPTACLE CARTS.

blocks or sections, keeping the figures well separated in the municipal books, the density of population per block calculated and the quantity of night-soil removed registered daily. Many of the Indian bazaars are long narrow ones, situated on a high ridge of ground, in which case it is desirable to have several trenching grounds, one for each block or group of blocks, instead of having one large one situated at a considerable distance from the centre of the town.

Conservancy Carts.

In order to effect the speedy removal of fæcal matter, the provision of suitable conservancy carts is of vital importance. Fig. 15, page 32, is an illustration of Crawley's Patent Night-Soil Cart, and is a good one for general purposes. It is made entirely of wrought iron, with an air-tight door for filling and emptying ; the latter is done by releasing a clip from the front of the barrel which connects it to the shafts and opening the lid, when the barrel turns on its centre and shoots out the contents. A 75-gallon capacity cart costs Rs. 130 ; a 110-gallon, Rs. 160 ; and a 200-gallon one Rs. 225. Small carts are preferable to large ones, as they take a shorter time to fill, and therefore tend to the more speedy removal of night-soil from crowded localities. They are

Receptacle Carts.

also more easy to handle at the trenching grounds.

It will sometimes be found advisable to provide receptacle carts for removing receptacles from latrines. Fig. 16, page 33, shows this arrangement. These, however, owing to their weight, and to the difficulties of placing and removing the receptacles when full cannot, excepting under special conditions, be recommended for municipal purposes. They cost, including 12-gallon receptacles, about Rs. 275.

Each latrine must be provided with a receptacle, into which the buckets are emptied, this being placed in a convenient position at the back of the latrine ; the cart starts on its rounds with six empty receptacles, visits the latrines where it picks up the full ones, and replaces them by clean ones. They are supplied in 6, 12 and 24-gallon sizes to suit requirements, and the arrangement avoids the nuisance of transferring the contents to a second utensil.

Hand Carts.

Hand carts are necessary in order to remove night-soil from houses built in narrow lanes and places

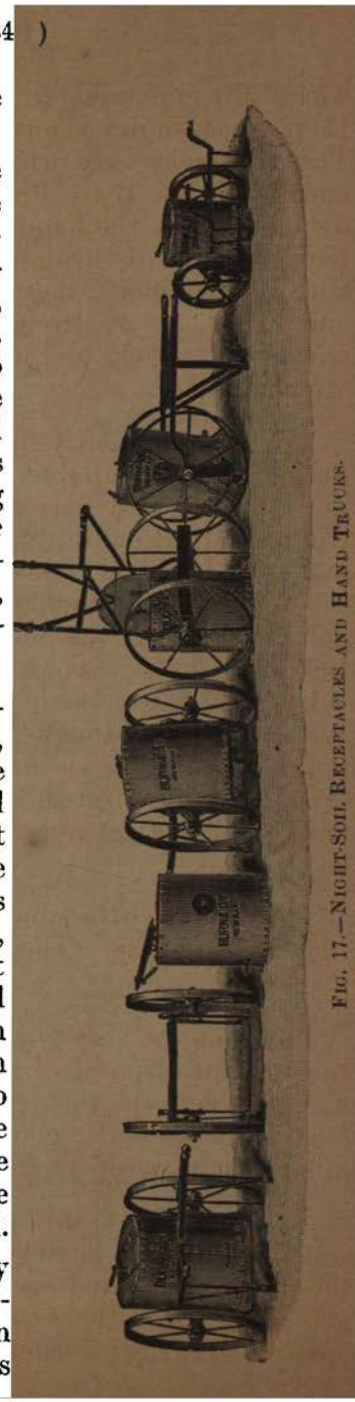


Fig. 17.—Night-Soil Receptacles and Hand Trucks.

where it is impossible to get bullock carts into. Fig. 17, page 34, shows a convenient arrangement for this. The receptacles vary in size from 12 to 33-gallons, and cost from Rs. 37 to Rs. 68 each ; the bodies are detached from the hand truck by simply raising the handles and disengaging the two-forked bearings with the trunnion ; they are fitted with a hinged lid and are made of strong galvanized iron ; the hand truck is of strong and light design, the whole being of wrought-iron.

Cess Pools.

Where regularly-flushed masonry-lined side drains are unavailable, the drainage from houses must be led into masonry-lined cess-pools, which will be cleaned out daily by the municipal sweepers, and the contents removed in conservancy carts. These cess-pools should be semi-circular in shape, and plastered on the inside with Portland cement. In many cases, where masonry drains exist, it will be found possible to intercept this sullage, and purify it through Biological Agency in small tanks, filled with pieces of vitrified brick, broken so as to pass through a 2-inch ring. The broken bricks will last for about a year, when they should be renewed.

Sullage Filter.

A drawing of a small Sullage Filter is given in Fig. 18, page 36. The estimated cost of which is Rs. 180.

Prompt Disposal.

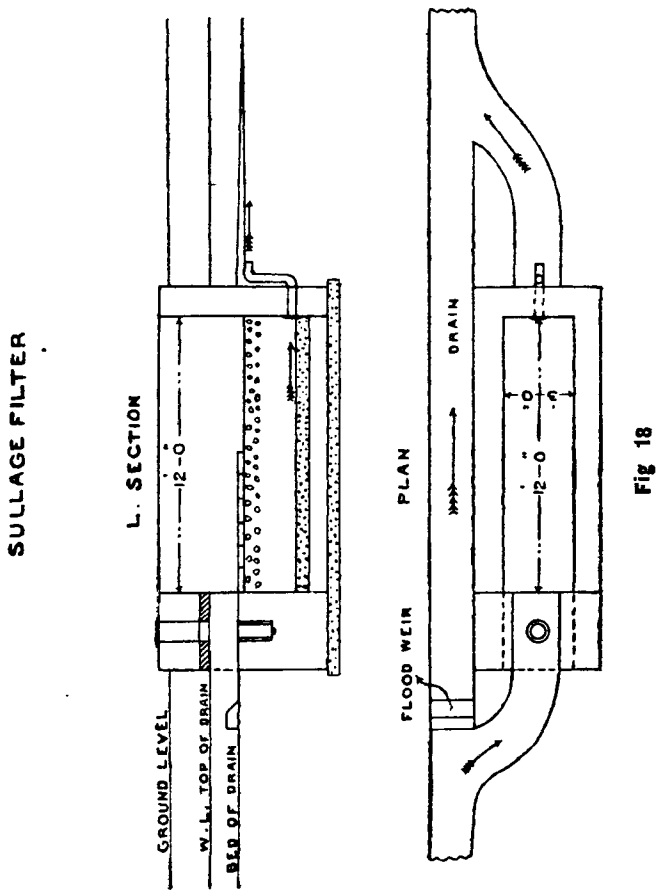
It is of the very greatest importance to insist on the prompt disposal of night-soil and refuse, and all means which aid this, good roads, proper care and feeding of animals, good carts, and the provision of houses for sweepers, help to a great extent.

Registering Private Latrines.

In order to systematise the removal of night-soil from private latrines, all these should be registered and numbered according to the beats of the attendant, or otherwise definitely indicated and located, and the sweepers told off accordingly.

Wheels and Axles.

When purchasing carts especial attention should be paid to the quality of the wheels and axles. The carts should not be too heavy and must be of a convenient height to facilitate working.



CHAPTER VII.

Disposal of Night-Soil and Trenching Grounds.

Night-soil is generally disposed of by being buried in trenches, but these are frequently too deep: purification largely depends on the action of the aërobic bacilli, that is, the group of microbes which live close to the surface of the soil and require air for their existence; these swarm in the top layers of the earth, but are not found at a greater depth than 1 foot and diminish enormously in number as this is approached. In order to obtain the best results, both from a purificative as well as a manurial point of view, the burial should be merely superficial and not exceeding in depth the limit of ordinary cultivation, in order to ensure the ground being thoroughly aërated.

Selection of Site.

The sites for trenching grounds should be carefully selected; light sandy soil unshaded by trees and well open to the south and west will give the best results. They should be well above flood level, at least 5 feet above the highest known flood, situated on the down stream side of the bazaar, connected by good *pucca* roads with it to allow of quick carriage, as time is the most important factor in the disposal of night-soil, and should not be in the direction of the prevailing winds with the town. A fringe or belt of bamboos between the town and trenching grounds will be found of the greatest use in keeping off flies which might be blown into inhabited neighbourhoods, and which are a most dangerous factor in disseminating disease.

Burdwan Trenching Ground.

At Burdwan in Bengal there is a successful example of what can be done with trenching grounds

from a financial point of view. There the night-soil of the Northern Section of the Municipality, where the latrine system is in force, and which has a population of about 23,000, is mainly disposed of in a permanent trenching ground of 18 bighas in area. This is collected from private latrines in covered buckets and deposited in the conservancy carts at the public latrines, whence it is removed to the trenching grounds, where trenchers are told off for each latrine group, who excavate the trenches and are in charge of them; these trenches are 3 feet wide, $1\frac{1}{2}$ feet wide, 12 to 15 feet in length and 1 foot apart. The carts empty the night-soil in from one end until a height of 9 inches of liquid is attained, the excavated earth being then replaced. During the rainy season Indian corn is grown, and in the cold weather cabbage, cauliflower, Bengal pumpkin, and other kitchen vegetables, for which there is a ready sale in the local bazaar.

The trenching ground during the current year 1913-14 has been leased out for Rs. 600.

Cultivation of Jute.

In the damp climate of Bengal jute has been found to grow very luxuriantly on newly-trenched ground and yields an abundant crop; it exhausts the soil so much that after the crop has been cut the field can be re-trenched, an important point when the subsoil water is practically 12 or 18 inches from the surface while the jute is growing. Another advantage in growing jute is that in certain localities there is a difficulty in finding a market for vegetables grown on a trenching ground.

Muzaffarpur Jail.

In Muzaffarpur Jail the trenches were made 1 foot deep, 1 foot wide, and 1 foot apart, and varying in length according to requirements; 3 inches of night-soil are filled in and covered over with the excavated earth; 20 trenches are always kept ready, being excavated the day before. Corn is found to grow luxuriantly after the trench has been filled in for a month, and other kinds of vegetables, excepting

potatoes, after two months. Urine and sullage water are buried in different fields and at a considerably greater depth.

Allahabad.

At the Government Farm at Allahabad (United Provinces) the system known as the Allahabad Shallow Trench was in successful operation, and provided for the whole of the cantonment and half the municipal population; there is an unlimited area of land available, the soil being of various kinds, black cotton, sandy loam and stiff clay. The only crops grown are grass and sorghum, and it is found that the manurial value of the night-soil is not exhausted for three or four years. Trenching can, however, be done every third year on the same land without making it "sewage sick;" land which was worth Rs. 2 will, after trenching, fetch about Rs. 10 per bigha for seven or eight years.

At Meerut for the year 1911-12 the sale-proceeds of night-soil and city sweepings amounted to Rs. 12,871, and at Furrakhabad *cum* Fatehgarh to Rs. 18,317.

Allahabad Shallow Trench System.

The area required for the contents of a 60-gallon conservancy cart is 80 sq. ft., the most suitable dimensions being 16 feet long by 5 feet wide; 3 inches of the top surface of this space is removed and placed on the embankments of the plot near which the first line of trenches is dug; the subsoil thus exposed is then well cultivated and pulverized to a depth of 9 inches, when the contents of the cart are tipped into the centre of the trench; the liquid matter rapidly sinking into the loosened soil, while the solid excreta remains on the top in a layer less than $\frac{1}{8}$ inch in thickness; 3 inches of earth are then similarly removed from the next trench which is parallel to the first, no intervening space being left, and thrown over the night-soil in the latter. The practical working is very simple, as all that has to be done, is to see that a sufficient number of trenches for the daily supply are dug the day before and the earth from them

placed over the filled ones. It has been found from experience that night-soil, thus treated, decomposes in less than a week and, if dug then, no trace is observable ; the effluvium disappears after three days, and crops are successfully grown immediately after trenching. The Shallow Trench System is by far the most scientific one, but requires a large area of land, working out to 545 sixty-gallon carts per acre. At Muzaffarpur during 1912-13, part of the night-soil was sold for Rs. 1,200, and part of it trenched in the municipal trenching ground, which was leased out for Rs. 1,045. The practical objection to this system is the fly pest. It is therefore only applicable where the trenching grounds are remote, and to the leeward side of the town. Sprinkling chloride of lime or quicklime on the top of the trenches prevents the breeding of flies. The researches of Majors Firth and Horrocks, R.A.M.C., published in the *British Medical Journal*, however, show that the enteric bacilli is capable of surviving in soil for much longer periods than has been believed possible. These can exist apparently in ordinary soil for 65 days, in sewage-polluted soil for at least 53 days, while in soil sufficiently dry to be blown about in dust for 25 days, and for about a similar period when exposed to a hot summer's sun. The authors of this note have also proved experimentally the translation of infective material from sun-dried and dusty soil by means of wind, as also by flies which have walked over or fed on polluted earth, indicating the advisability of treating night-soil, especially from Military Cantonments, in septic tanks and filter beds before applying it to soil—*vide* Chapter IX, page 50.

Area of Trenching Ground.

In order to arrive at the area necessary for a deep trenching ground for a bazaar of 10,000 inhabitants, and assuming that not more than $\frac{1}{8}$th of a gallon of night-soil per head per diem is removed, provision will have to be made for 1,250 gallons or, say, 200 cub. ft. If the trenches are made 1 foot wide, 1 foot deep, and 1 foot apart, and are filled with 6 inches

of night-soil, 400 cub. ft. will be required daily, or allowing for roads and divisions between the plots, say 12 acres, for a year's work, or, in other words, the area required is, one acre for 833 persons. The trenches should be divided up into plots or sections for each latrine circle, excavated, when weather permits, at least a week before they are used so as to aërate the earth ; the bottom of the trench should also be dug up to a depth of 9 inches for the same reason.

The following extract describes somewhat forcibly what may, and undoubtedly does frequently occur in many instances :—

" Trenching again is a success in dry soils, but a good deal of ground is required, and sufficient trenching ground is not always available within practically workable distances of the night-soil producing areas (public and private latrines), and often enough, whereas it may be quite successful in a given ground in the hot weather, it will, in the same ground, however fresh, prove an absolute failure in the rains, when, owing to the high water-level in the subsoil, everything trenched is brought to the surface by the gases of putrefaction, and the entire area trenched becomes a pestilential bog, crawling with maggots, bubbling with the foulest odours and swarming with blue-bottle flies, whose chief delight is to frequent the houses in the neighbourhood and infect both food and drink."

CHAPTER VIII.

Collection and Disposal of Refuse.

The scavenging of a town and the disposal of the refuse has probably more effect on its sanitary state than anything else ; dirty rags, dead grass and other refuse lying about, are ideal homes for germs of disease to live and flourish in, and these, when a shower of rain falls, very frequently get washed into the water-supply. The modern system of cremation in specially constructed incinerators is the only safe method of disposal of town sweepings. Even in England, where the water-supply is, in the majority of cases, not affected, careful observations have proved that there is an increased liability to enteric fever in the localities of refuse heaps. In an Indian bazaar dependent on wells and tanks for its water-supply, anything more barbarously insanitary than the filling up of deep tanks with town refuse is hard to imagine. Deep burial keeps the germs of disease alive, probably for years, in the very stratum the drinking water is frequently taken from.

Dust-bins.

In order to facilitate the collection of refuse, dust-bins are of great use ; they should, however, not be so large as to become unwieldy, as it is much more preferable to have numerous small ones conveniently placed, than a few large ones ; the simplest shape is a circular one of corrugated iron, open at both ends, provided with a pair of handles, and resting on a brick on edge platform, with a groove therein into which the bin fits, on the same level as the street. When the collecting cart comes round, the bin is lifted, the contents shovelled into the cart, and the bin then replaced ; these should be cleared at certain fixed hours, and house-holders ought to be encouraged

to have private ones of small size near their doors if space permits. Fig. 19 is an illustration of these bins, and being made of galvanized iron are not liable to rust. They vary in price for bins 2 feet 9 inches in height and 2 feet in diameter from Rs. 6 each, without angle iron rings at top and bottom, to Rs. 12-8 each with rings. These receptacles should not be placed within 50 feet of any well or tank.

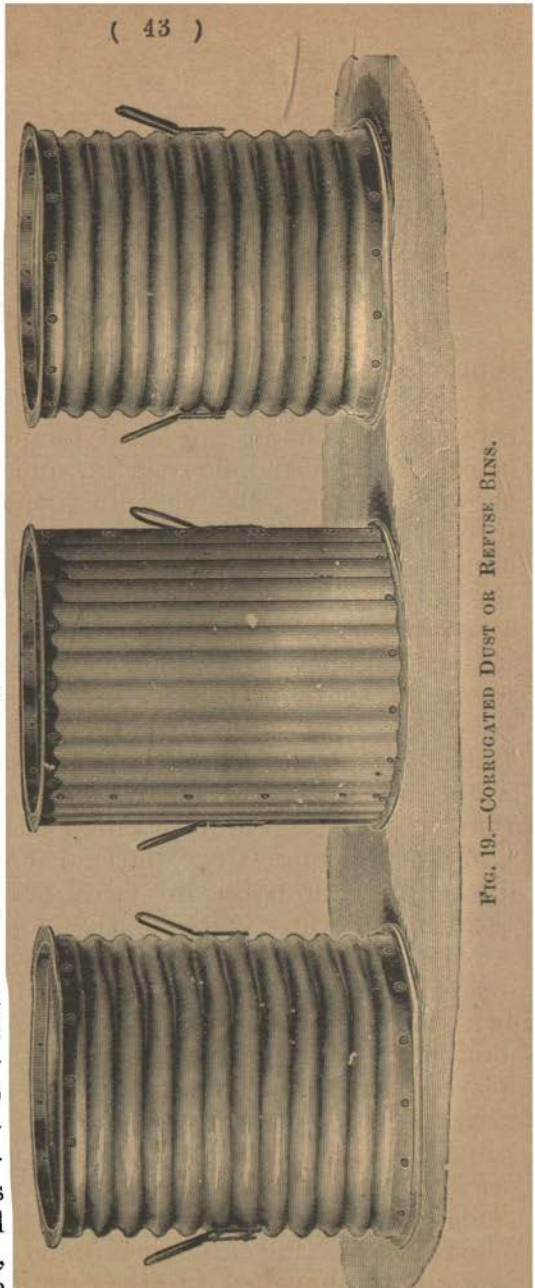


Fig. 19.—Corrugated Dust or Refuse Bins.

The selection of strong and serviceable refuse carts is also a matter of importance, especially as regards the axles and wheels. Fig. 24, page 48, is an illustration of a cheap but effective type. The cost is Rs. 120 for a cart of 30 cub. ft.

capacity, Rs. 150 for 50 cub. ft., and Rs. 200 for 90 cub. ft.

All the working parts should be of standard size, duplicates of which can be economically purchased and kept in stock in the event of a breakdown, when they can be easily fitted by unskilled labour. This is important, as few municipalities have good workshops. The axle box in the wheels should invariably be the full width of the hub. A new axle, with axle box and sleeve or jacket to take the wear and tear off the axle, can be made up at a small cost, Fig. 20. In the Patna Municipality this is supplied complete for Rs. 9-2-0.

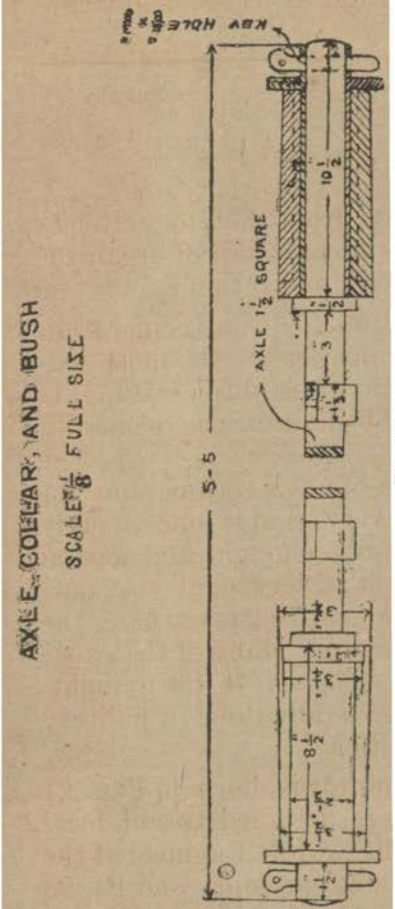


Fig. 20.

In Municipalities where the quality of work warrants it, it will be found economical to maintain a small workshop where repairs can be done, but this must be properly organized. The following cart Register kept up in Patna City will simplify control of the carts, and ensure proper repairs being done. It commences with an Index, each cart is numbered consecutively, whether it be water, conservancy or refuse cart, and the number permanently marked

on it. At the ledger folios referring to any cart appears—

1. The number of cart.
2. Date when made.
3. Maker's name.
4. Where worked (ward and by whom) and below that

Date.	Note of repairs.	Cost.	Remarks.
1902 12 11	New axle	Rs. 9-2-0	

This is of course separate from the Stock Register, and may appear to be a mere detail of organization, but is very useful in administration.

For towns and small Municipalities Incineration is by far the safest, and in most cases, the most economical method of getting rid of rubbish. If night-soil be mixed with the rubbish nuisance generally arises.

There are various types of incinerators, but for burning town refuse only a very simple one, merely a furnace and chimney, is quite enough, and several of these can be constructed at a very small cost outside a municipality at convenient centres, where the smoke will not cause a nuisance. Many of the existing incinerators have been designed to burn night-soil as well as refuse, as is generally done in military camps and forts on the frontier.

Madras Incinerator.

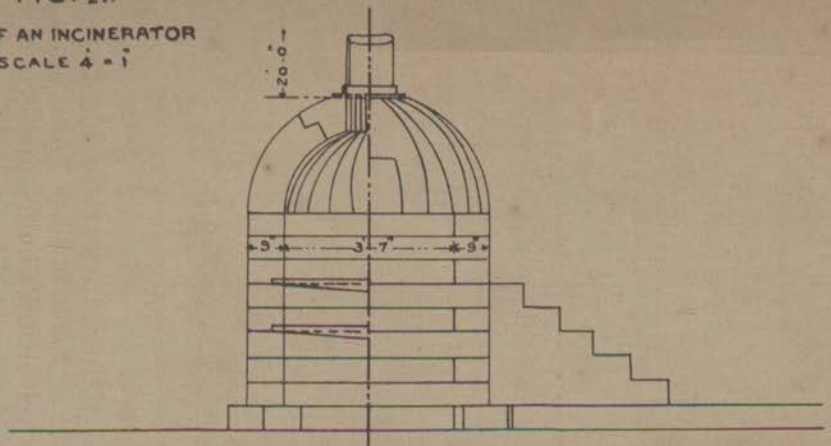
The Madras type Incinerator is shown in Figs. 21 and 22, page 46. These were designed to suit local conditions by Mr. C. L. Griffith, while Engineer of the Corporation, and cost Rs. 100 for masonry and Rs. 25 for ironwork. There are a considerable number of these at work, distributed throughout the Municipal area, so as to reduce the load for carting to a minimum, a very important factor in a straggling town.

The Sealkot Improved Type Incinerator is also a suitable and economical one. A 4′ diameter one

FIG. 21.

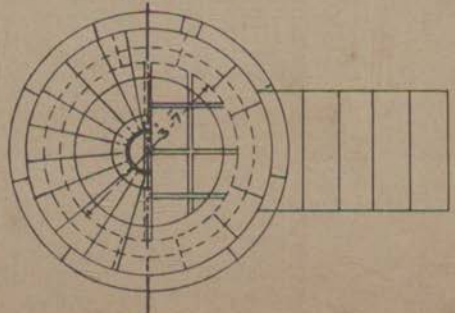
PLAN OF AN INCINERATOR
SCALE 4 = 1'

HALF SECTION & ELEVATION



PLAN

FIG 22



is capable of burning about 300 cub. ft. of rubbish daily, and it costs about Rs. 400. *See* Fig. 23.

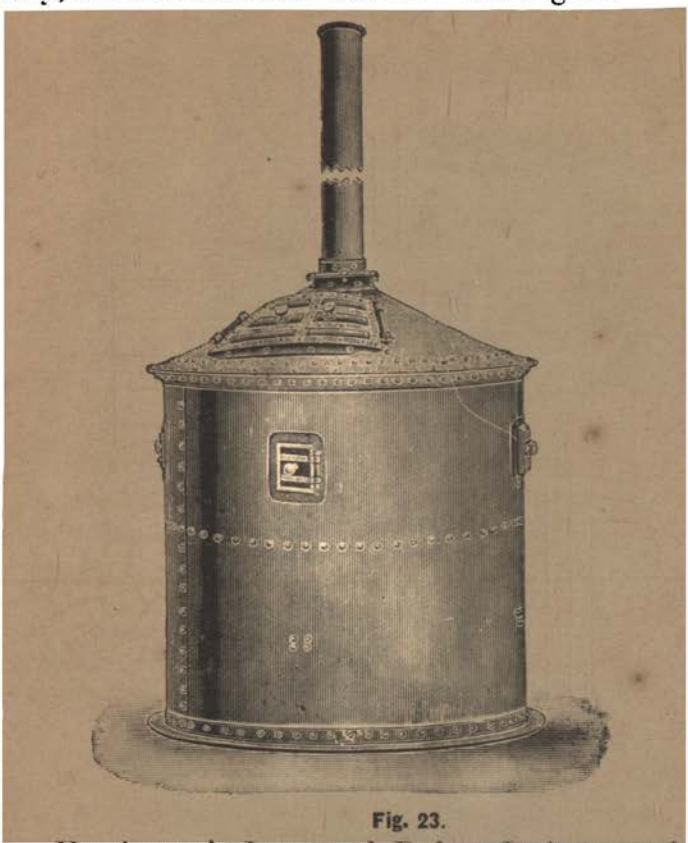


Fig. 23.

Harrington's Improved Refuse Incinerator has been in use for several years. Each furnace burns from 500 to 1,500 cub. ft. of refuse in 24 hours, and is attended by one man who works in 8-hour shifts, and who charges the furnace at the top and removes the ashes from below the fire bars. The fires do not die out when the furnace is properly charged, and no coal or other fuel is required. It was patented by Mr. R. R. Harrington.

Harrington's Improved Incinerator.

The Horsfield Back feed continuous grate type with 6 cells, designed to dispose of 10 tons each in 24 hours, has been adopted for Colombo, the cost of

Horsfield Incinerator.

destruction varying from Rs. 1·30 cents to Rs. 1·50 cents per ton.

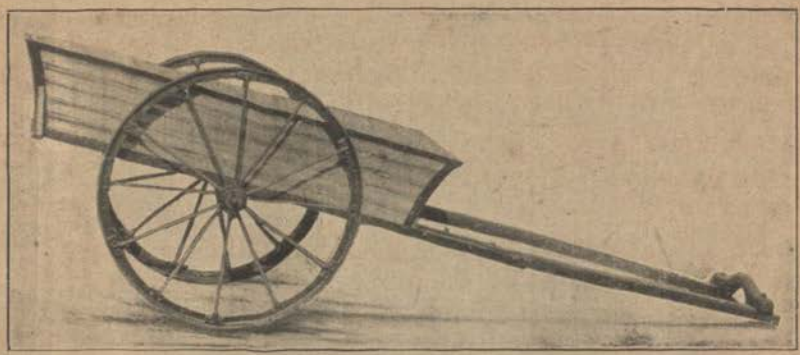


FIG. 24.—CORRUGATED IRON REFUSE CART.

Burning Refuse in Stacks.

A large amount of town refuse can be satisfactorily disposed of by stacking it judiciously and setting fire to it from the windward side, when it gradually and steadily burns away. This is, of course, only practicable during the dry weather months when the sweepings are comparatively dry. In this, as in every case of removal, the beats of the carts should be systematised and a fixed area allowed to each cart.

Filling hollows with refuse.

Where incineration is not practicable the only method of disposing of street sweepings is by filling up hollows or old tanks, when the following rules should be observed :—

1. The hollow or pit should first be pumped out quite dry ; if wet, a horrible nuisance is caused.

2. Where the hollow or pit is a large one a section of it should be bunded in, staked off, and filled up to surface level before the rest is proceeded with.

3. The sweepings, as soon as ground-level is attained, must be at once covered over with earth, or the débris from old houses, walls, etc., so as to

prevent them being exposed and acting as breeding-grounds for flies.

A rapid and effective method of filling a tank when land is available round its border is to excavate shallow pits parallel to its sides, the earth from which is thrown into the tank, and the pits then filled in with sweepings.

A form for regulating the progress of the work of filling up depressions or tanks is given in Appendix B, page 61.

Unless, under exceptional circumstances, it is most undesirable to fill up any hollow or tank in the vicinity of any well from which drinking water is obtained. It may possibly be found the lesser of two evils to fill up small tanks or hollows in the interior of a bazaar with refuse, as these are frequently in an undescribable state ; the charge made by a Municipality for doing this should, however, be so adjusted as to admit of the surface being well covered in with earth, which must, in all cases, be insisted on. If no charge is made, and no depôt for the refuse selected, it will be found that the cartmen will sell it by the cartload to irresponsible persons, when reasonable precautions as to covering in with earth and selection of site are not possible, the consequence being that innumerable breeding-places for flies are well distributed throughout the heart of a densely populated neighbourhood, in places where earth has been from time to time excavated for building huts.

CHAPTER IX.

Biological System for the Disposal of Night-Soil.

Since this chapter was written, some 12 years ago much research work has been carried out in 1906. This was in India first systematised by Dr. Fowler in his report on "Septic Tanks in Bengal" and has been carried on by Major Clemesha, I.M.S., Sanitary Commissioner, Bengal, whose work on "Sewage Disposal in the Tropics" published by Messrs. Thacker, Spink & Co., Calcutta, is a most useful one and should be consulted by those interested in the subject.

In the present state of knowledge of the science, it would be unsafe to discharge the efficient into a water-supply of small volume used for drinking purposes below the point of discharge, or in fact into any water which may be a potential source of water-supply, unless it be first sterilised. This can be easily and economically done with chloride of lime.

In dealing with the resultant liquid of bacteriological treatment it is safest to consider it as a possible source of danger, and to discharge it either into the storm-water drains of a town, on land for irrigation purposes, for which it is most valuable, or into a large volume of running water, as circumstances admit of.

The great advantage of bacteriological treatment of night-soil, and one which it is impossible to overestimate, is, that it enables the excreta to be disposed of when fresh, eliminates the necessity of stale night-soil being carted through crowded thoroughfares at a very low rate of speed, and consequent danger of the food and water-supply of the people being contamin-

ated by the germs of disease conveyed by flies, or blown on in the dust. Latrines can be constructed over septic tanks, the home of the anærobic bacilli, where the excreta at once passes in, or dumping septic tanks can be worked at the night-soil depôts, where the stuff is at present collected, as at Darjeeling.

In Military Cantonments, where enteric is generally more or less epidemic, it is most important that the night-soil be treated by biological methods before it be applied to the soil, as installed at most of the mills on the banks of the Hooghly, and at the East Indian Railway Workshops at Jamalpore.

Septic Tanks.

Of the various methods of bacteriological disposal, the closed septic tank is, for climatic reasons, the most generally suitable for India. In this the anærobic bacilli are provided with a congenial working place in the closed tank ; and the ærobic ones are similarly provided for in the filter beds ; the open septic tank, however, gives equally good results, as the scum, which rapidly forms on the surface, and which generally attains a considerable thickness, enables anærobic conditions to obtain in the tank itself, but care must be taken that this scum is not broken.

Filter Beds.

The ærobic Contact Bed filters are merely open tanks filled with coal, coke, or large cinders, through which the liquid is allowed to percolate at intervals. The bacilli live and flourish in these, and do their work during the periods from 2 to 4 hours the tanks are charged.

The percolating continuous filters are those over which the effluent is continuously sprinkled and through which the fluid slowly percolates. Experiments have conclusively proved that good results can be obtained from either when a suitable sewage is applied.

CHAPTER X.

General Sanitation.

Trees and tall crops.

All the lower branches of trees in crowded areas should be pruned; these are useless or superfluous for shade, and only impede the free circulation of air. This should be done by sawing off any branch flush with the main trunk, or with its main branch. In no case should a ragged stump be left, and, if possible, the wound should be smeared with tar. Lopping must be done with a handsaw and in no case with an axe; the best season for doing this is at the end of the cold weather, but it can also be done at the end of the rains. The final form of a tree should be a straight stem up to 15 or 18 feet, without a bough, and above that height its natural shape whatever that may be. This will allow of free ventilation of the roads and streets. For the same reason no tall crops, such as Genera, or Indian corn, should be allowed near houses, and jungle should be kept cleared as far as possible.

Tanks

Householders should not be allowed to excavate small tanks in their compounds to procure earth from for the plinths of their houses, as these become in time mere cesspools, where the inmates bathe, wash their clothes, and often drink the water. Further, these become suitable breeding-places for mosquitoes. Plots of ground should be set aside by Municipalities, where, for proper reasons, earth can be taken. These common excavations will in time become large tanks, which can be properly conserved and utilized. For the same reason earth for roads and railways should not be removed from isolated pits, but should be taken so that the resultant excavation forms one continuous channel running parallel with the road,

or should be taken in shallow layers so as to avoid the formation of a pit or hollow, the existence of which is especially objectionable in the light of recent research as mosquitoes breed and generate in them, and so spread malarial fever. Where such hollows exist, the growth of fish should be encouraged, as they feed on the mosquito larvæ when present.

Cultivation within urban limits.

From the experience of troops on service, it is found that camping near recently turned-up soil is usually followed by fever. Ploughing up of land for agricultural purposes should, if possible, be prevented within municipal urban limits. In most municipalities there is a suburban area which is pretty well all cultivated, but cultivation in densely populated areas, as often occurs, should be discouraged.

Dhobies.

Dhobies should not be allowed to wash clothes in stagnant tanks, as it has been proved that the spread of parasitic eczema, or dhobies' itch, is thereby facilitated. Where a water-supply exists a small washing platform with taps should be provided free of charge by the Municipality. Where not, they should be made to wash in running water, or in tanks specially passed by the medical officer. It is most important that all dhobies be registered, licensed and told off to the different ghats ; it may be free of cost to them in the first instance, but after the system has been successfully introduced, well-to-do employees can easily be induced to pay a small annual fee for superior accommodation. This will eventually fully cover the cost of the necessary supervising establishment and incidental expenditure.

Markets.

The importance of the regular inspection and control of markets, through which the food-supply of a large proportion of the inhabitants passes, can hardly be over-estimated. In these, special accommodation and water-supply suitable for the articles for sale, *e.g.*, fish, vegetables, meat, and livestock

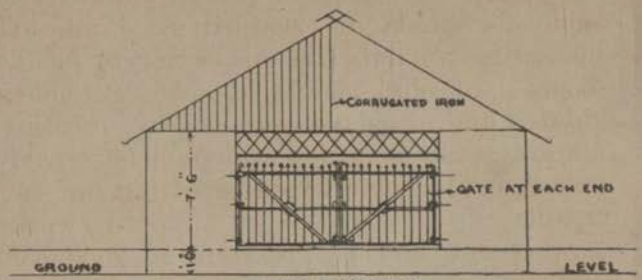
should be provided, and a staff employed to see that the existing laws are duly enforced, and that the quality of the food-stuff exhibited for sale is such as should be permitted. Public slaughter-houses for animals, the inspection of meat, and the disposal of offal should also be systematically regulated and inspected. The cost of erecting suitable market accommodation will soon be repaid and the investment become a source of income to a Municipality if the scheme is properly worked. The great point is the provision of good ventilation, drainage, and of a water-supply for flushing purposes. A design of an inexpensive market of 40 stalls for the Muzaffarpur Municipality constructed in 1902, at a cost of Rs. 4,786, is given in Fig. 25, page 55. This for the past three years gave an average income of Rs. 253. A loan of Rs. 4,800 at 4 per cent., repayable in 30 years, would entail an annual expenditure of say Rs. 278 (*see* Table of calculations of repayment of loans by equal instalments, Appendix E, page 68), so the results there are not satisfactory from a financial point of view.

Disposal of Dead. Burning Ghâts.

The scarcity of timber generally prevailing, and its consequent expense, makes the process of cremation among the poorer Hindus frequently a fârce, the corpse being generally merely charred, and then thrown into the nearest river, which thereby may be contaminated by the germs of disease; often the professional cremator does nothing more than throw the body into the water. It is time that rich Hindus came forward and constructed proper crematoria in the towns on the banks of the Ganges for the suitable disposal of their dead. Coal should be used and the burning ghâts be looked after by Brahmins, as at Kalighat in Calcutta. In Muzaffarpur, a new burning ghât on the banks of the river, down stream of the town, was opened under the control of the Municipality. A waiting-room to shelter the persons accompanying the corpse will be

FIG. 25

MUNICIPAL MARKET 40 STALLS



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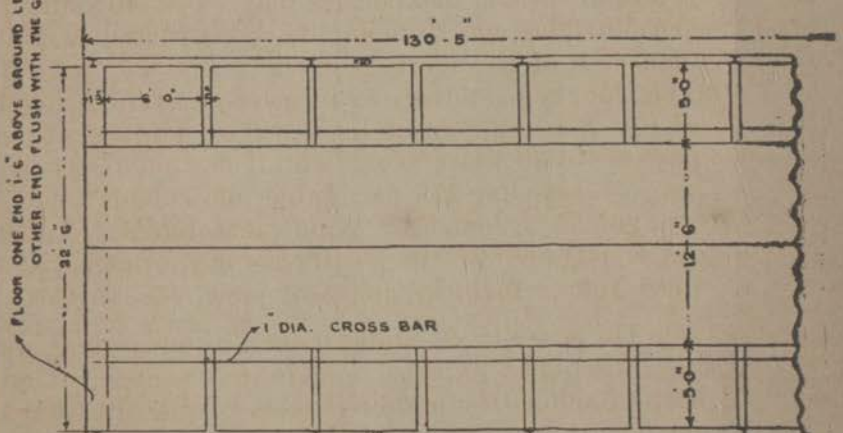

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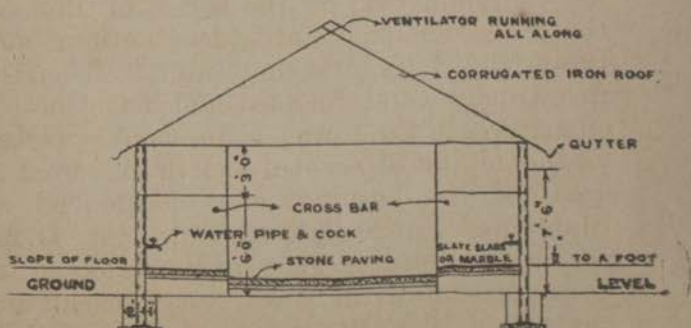

CROSS SECTION

constructed at the cost of a leading zemindar; and the sale of fuel was regulated. For the cremation of an adult corpse this is supplied for about Rs. 2 and for child Re. 1, varying with the seasons, but private supply was allowed, provided it be sufficient for perfect combustion of the body. At least 9 maunds of mango wood is required to burn an adult corpse properly, the rate for this being about 5 maunds for a rupee.

Burial-grounds.

Mahommedan burial-grounds should not be allowed near crowded areas, or the sources of water-supply. In most towns these will be found to be overcrowded; new ones should be opened under municipal control, as provided for in sections 254 to 260A, Part VI of the Bengal Municipal Act. An area of half an acre for every 1,000 Mahommedan inhabitants is desirable if land is available, but may be reduced to quarter of an acre where such is very expensive. This allows of the graves being undisturbed for a period of seven years.

Ruined houses.

Where a house has been dismantled, or is in ruins, the owner should be made either to repair it or remove the materials; the remains of walls serve as a cover for the committal of nuisances and the deposit of refuse.

Building Regulations.

Building Regulations should be adopted in all Municipalities. Those framed for Patna City under section 241, Part VI, of the Bengal Municipal Act, are given in Appendix D, page 63. The rule that no building in any street shall be higher than the distance from its base to the opposite side of the street is a very essential one to observe. In the Bombay Improvement Trust the angle of $63\frac{1}{2}$ from the opposite side of any street or lane, regulates the height permissible in any building.

APPENDIX A.

MODEL RULES AS TO PRIVATE PRIVIES AND URINALS.

(GOVERNMENT OF BENGAL.)

[*See Act III of* 1884, *Section* 350 (*e*).]

1. (1) No privy shall be placed in the space required by this Act to be left at the back of a building—

(*a*) unless the total height of the privy does not exceed eleven feet ; and

(*b*) unless there is a space of at least four feet between the nearest wall and the service aperture of the privy.

(2) No privy situated in, or adjacent to, a building shall be placed at a distance of less than—

(*a*) six feet from any other building which is a public building ; or

(*b*) four feet from any other building which is, or is likely to be, used as a dwelling-place, or as a place in which any person is, or is intended to be, employed in any manufacture, trade or business.

Provisions of access to service privy from street.

2. (1) No privy shall be placed on any upper floor of a building.

3. (1) If there is no convenient access from a street to any privy, the Commissioners may, if they think fit by written notice, require the owner of the privy to form a passage giving access to the privy from the street.

Models and type-plans.

(2) Every notice served under sub-rule (1) must require that such passage be formed at ground-level, but not less than four feet wide, and be provided with a suitable door, and must inform the said owner that the passage may, at his option, be either open to the sky or covered in.

4. Models and type-plans of privies and urinals, approved by the Commissioners, with estimates of the cost of constructing privies and urinals in accordance therewith, shall be kept in the Municipal office and shall be open to inspection by any person at all reasonable times without charge; but no person shall be bound to construct any privy or urinal in accordance with any such model or type-plan if the same be constructed in accordance with the other rules contained in this Schedule.

Drain.

5. (1) A drain must be provided for every privy and every urinal.

(2) Such drain must be constructed of some impervious material, and must connect the floor of the privy or urinal—

(*a*) with a drain communicating with a municipal drain or sewer; or

(*b*) if permitted by the Commissioners, with an impervious cesspool, the contents of which can be removed either by hand, or by flow after filtration.

Floor.

6. (1) The floor of every privy and urinal—

(*a*) must, if the Commissioners in any case so direct, be made of one of the following materials to be selected by the owner of the privy or urinal, that is to say, glazed tiles, artificial stone or cement; or

(*b*) if no such direction is given, must be made of thoroughly well-burnt earthen tiles or bricks plastered, and not merely pointed, with cement; and

(*c*) must be in every part at a height of not less than six inches above the level of the surface of the ground adjoining the privy or urinal.

(2) The floor of every privy and every urinal must have a fall or inclination of at least half an inch to the foot towards the drain prescribed by rule 5; and the platform must be similarly sloped towards the aperture.

Walls and roof.

7. The walls and the roof (if any) of every privy and urinal shall be made of such materials as may be approved by the Commissioners:

Provided that—

(*a*) in the case of privies, the entire surface of the walls below the platform shall either be rendered in

cement or be made as prescribed in clause (*a*) or clause (*b*) of rule 6.

Platform.

8. The platform of every privy or urinal must either be plastered with cement or be made of some water-tight non-absorbent material as prescribed in rule 6.

Ventilation of privies in, or adjacent to, buildings.

9. Every privy or urinal situated in, or adjacent to, a building must have an opening, of not less than three square feet in area, in one of the walls of the privy, as near the top of the wall as may be practicable, and communicating directly with the open air.

Regulation of service privies constructed for use in combination with a moveable receptacle for sewage.

10. Every privy must be constructed in accordance with the following provisions:—

(*a*) the space beneath the platform of the privy must be of such dimensions as to admit of one or two moveable receptacles for sewage of a capacity not exceeding one cubic foot, being placed and fitted beneath the platform in such manner and position as will effectually prevent the deposit, otherwise than in such receptacle of any sewage falling or thrown through the aperture of the platform;

(*b*) the privy must be so constructed as to afford adequate access to the said space for the purposes of cleansing such place and of placing therein and removing therefrom proper receptacles for sewage;

(*c*) the said receptacles must be water-tight, and must be made of metal if their capacity is over half a cubic foot, or of well-tarred earthenware or glazed stoneware if their capacity is less than half a cubic foot;

(*d*) the door for the insertion and removal of the receptacles must be made so as to completely cover the aperture.

Enforcement of the foregoing rules in the case of future privies or urinals.

11. (1) If any privy or urinal erected or re-erected after the passing of these rules is so constructed as to contravene any of the provisions of this Schedule, the Commissioners may, by written notice, whether or not the offender be prosecuted under the Municipal Act before a Magistrate, require—

(*a*) the occupier of the building to which the privy or urinal belongs, or

(*b*) (if the privy or urinal does not belong to a building) the owner of the land on which the privy or urinal stands, to make such alterations as may be specified in the notice with the object of bringing the privy or urinal into conformity with the said provisions.

APPENDIX B.

REMOVAL OF TOWN SWEEPING.

Muzaffarpur Municipality.

WARDS NOS. 1 AND 2.

Name of Depôt, Juran-Chupra.

Quantity required to fill up tank or hollow, 67,570 cub. ft.

November 1902.

Serial number of cart.	Name of carter.	Capacity of cart in cub. ft.	NUMBER OF TRIPS DAILY.																													Quantity of rubbish in cub. ft. deposited by each cart daily.	Quantity rubbish n cub. ft. deposited by each cart n month.
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
1	Bechná ...	24	2	2	3	2	3	2	2	2	2	2	2	2	3	2	3	3	2	2	2	3	2	2	2	2	2	2	3	2	2	3	..	54·4	1,632
2	Jhoomak Dome ...	24	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	...	48·0	1,440
3	Manglá ...	24	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	3	2	2	2	2	2	2	2	2	3	2	2	2	2	...	51·2	1,536
4	Jamná Bará ...	24	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2	...	48·6	1,440
5	Musamat Rukminiá ...	24	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2		48·0	1,440
6	Bhádai	24	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	...	49·0	1,488
7	Musamat Rebia ...	24	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	...	48·0	1,440
8	Akloo Chotá ...	24	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	..	48·0	1,440
9	Musamat Bhagwániá	24	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	...	48·0	1,440
		Total ...	18	18	19	18	19	19	18	18	18	19	19	18	19	18	19	19	19	18	18	19	18	19	18	18	18	19	19	18	18	19	...	...	13,296

Total quantity of rubbish deposited at Depôt during month in cub. ft. 13,296.

Cubical capacity of hollow still remaining to be filled up, 54,274.

APPENDIX C.

MUZAFFARPUR MUNICIPALITY.

WELL REGISTER.

1902.

Ward II.

Serial number on map.	Mahulla.	Population of Mahulla.	Name of Well.	Condition of Well.	Depth.	By whom owned.	Date when last cleaned.	By whom cleaned.	Date of notice to owner.	Remarks.
139	Sarayagunj	...	Bulaki Sahoo ...	...	33 ft.	Hiraman Sahoo ...	1901	...	30-5-02	
140	...	...	Jadoo Baboo ...	...	49 ft.	Jadoo Baboo ...	...	..	20-5-02	
141	...	..	Laljee Chowdhry ...	...	37 ft.	Laljee Chowdhry ...	...	..	Do.	
142	...	..	Rai Babu Permeshar Narayan Mahtha Bahadoor.	...	30 ft.	Rai Babu Permeshar Narayan Mahtha Bahadoor.	...	...	Do.	
143	...	...	Ditto .	...	25 ft.	Ditto ..	...	..	Do.	
144	...	..	Ditto ...	..	27 ft.	Ditto ...	...	..	Do.	
145	.	...	Do. in Dharmasalla ...	...	54 ft.	Ditto ...	1901	...	Do.	
146		...	Ditto ..	.	37 ft.	Ditto ...	1901	.	Do.	
147	.	. .	Barhamdeo Narain ...	...	27 ft.	Barhamdeo Narain	1901	...	2-6-02	
148	..	. .	B. Buldeo Prosad Sahoo ...	. .	30 ft.	Buldeo Prosad ...	...	.	20-5-02	
149	..	..	Ditto .	. .	25 ft.	Ditto ...	...	..	Do.	
150	...	...	Ditto ...	...	23 ft.	Ditto ..	...	...	Do.	

APPENDIX D.

BUILDING REGULATIONS FRAMED UNDER SECTION 241, BENGAL MUNICIPAL ACT.

INTRODUCTORY.

1. Any powers of the Chairman under these Rules can be delegated by him to the Vice-Chairman.

PART I.—BUILDING SITES.

Conditions as to use of building sites.

2. No piece of land shall be used as a site for the erection of a building.

(1) If the building is to abut on a road, unless the site is of such a shape that the face of the building can be made parallel to the line of the road, or as nearly parallel to the said line as the Chairman may consider practicable ; and,

(2) If the building to be erected is a public building, or a dwelling-house—

(*a*) Unless the site is certified by the Overseer to be dry and well-drained, or to be capable of being dried and well-drained, in which latter case instruction should be furnished to the applicant as to what improvements are necessary before a certificate can be granted. It rests with the Chairman to decide in each case whether any certificate is necessary at all.

(*b*) It the site is a tank filled up with earth, unless the site has been filled up for at least five years, with the proviso that if the foundations reach to the original ground there is no limit as to time.

(*c*) If the site has been filled up with or used for depositing rubbish, offensive matter, or sewage, unless the site was so filled up or last so used more than five years previously and unless the Chairman has examined the site and granted a certificate to the effect that it is, from a sanitary point of view, fit to be built upon.

PART II.—BUILDINGS GENERALLY.

Height.

3. (1) If a building is situated at the side of a road no portion of the building shall be higher than the distance from its base to the opposite side of the street.

Explanation.—If a building be placed at the edge of the road its height must not exceed the width of the street; but if the building or one or more of its stories be set back, the height of the building may be increased as much as the basement of the increased portion is distant from the adjoining edge of the road.

(2) In the case of any building which is re-erected in a road in existence at the time when these rules come in force which is less than 25 feet wide but more than 20 feet, the proportion of height to width may be as five to four up to a limit of 25 feet.

(3) Notwithstanding anything contained in sub-rule (1) or sub-rule (2) the Chairman may give permission for building houses in the cases of roads or lanes of less than 20 feet wide, after personal inspection in each case.

(4) If a building is situated on a corner plot, the height of the building shall be regulated by the wider of the intersecting streets.

Level of floor.

4. The floor or lowest floor of every building erected or re-erected from the ground level must be constructed at such level as will admit of—

(*a*) The construction of a drain sufficient for the effectual drainage of the building, and placed at such level as will admit of the drainage being led into some Municipal drain at the time existing or projected.

(*b*) The provision of the requisite communication with some drain into which the drainage may lawfully be discharged, at a point in the upper half of such drain, or with some other outfall into which the drainage may lawfully be discharged.

Building over Municipal drain.

5. No foundation of any building shall be placed over any Municipal drain, nor shall any superstructure whatever, whether verandah, balcony, eave, or any other portion of the building, project beyond a vertical line drawn through the centre of the drain, and if there be no drain, not beyond 1 oot 6 inches from the edge of the road. But no material or

structure of any kind at or below the level of 6 feet from the ground, with the exception of entrance culverts, allowed under Rule 7, shall project over any part of a drain.

Entrance culverts.

6. The applications which are filed for entrance culverts must contain the following particulars :—

(1) Length.

(2) Breadth beyond drain.

(3) Ventage allowed.

(*a*) Ordinarily the following dimensions will be allowed for foot traffic :—

(1) two feet.

(2) ten inches.

(3) same size as area of drain up to a maximum of three square feet.

The number of entrance culverts in any building shall not exceed the number of separate shops or dwelling-houses. The intervening space between culverts over a drain shall not be covered over by planks, stone slabs or any other substance.

(*b*) For wheel traffic the size and the nature of the entrance culverts are left to the discretion of the Chairman.

Balcony.

7. No balcony shall be erected in any road, street, or lane which is not maintained by supports which in the opinion of the Chairman are sufficiently strong.

Distance between building line and street alignment.

8. In any road laid out after these rules come into force in which continuous building is allowed, the distance between the building line and the street alignment shall not be less than 4 feet.

PART III.—Masonry Buildings Generally.

Plinth.

9. The plinth of any new building must be at least one foot above the level of the centre of the nearest road, provided no one is required to build a plinth higher than three feet above the ground.

Outer walls.

10. The outer walls of a masonry building must be constructed of burnt brick or some other hard and incombustible substance.

Walls in building of more than one storey.

11. If a masonry building exceeds 30 feet in height, all except the topmost storey should be built of well burnt bricks and lime mortar.

Terrace roof.

12. No part of a flat terrace roof or part of a parapet shall extend beyond the outer face of the wall on which it is supported.

PART IV.—Dwelling-Houses and other Domestic Buildings.

Proportion of site for dwelling-house which may be built upon.

13. The total area covered by all the buildings (including verandahs erected or re-erected on any site used for a dwelling-house) shall not exceed three-fourths of the total area of the site. But in the case of rebuilding this rule will not apply in a case in which the site is less than 500 square feet.

Open space in rear of building.

14. Except in localities where the erection of only detached buildings is allowed, there must ordinarily be, in the absence of any specific permission of the Chairman to the contrary, in the rear of every domestic building an open space extending along the entire width of the building of not less than 10 feet.

Interior courtyards and outwards open spaces to be raised and kept open.

15. Every interior courtyard and every open space prescribed by rule 15 must be raised at least six inches above the level of the centre of the nearest street or road so as to admit of easy drainage into the street.

16. All living rooms should be so placed as to get light and air. For that object all such rooms should have at least one window opening to the outer air direct, or into a verandah.

Height of room.

17. The height of the room on the basement floor shall be not less than nine feet.

Water spouts.

18. Water spouts should be so arranged as to discharge water in a Municipal drain or on land belonging to the proprietor of the house to which the water spout is attached.

PART V.—Applications for Approval of Sites for, and for Permission to Erect or Re-erect, Masonry Buildings.

Application for approval of site for erection or re-erection of masonry buildings.

19. (1) Every notice under section 237 of the Bengal Municipal Act for the erection or re-erection of a house not being a hut must be in writing and should state the boundaries of the site, the number assigned to it in the assessment book, and its dimensions.

(2) The site plan sent with such an application must be drawn to a scale of not less than $\frac{1}{30}$th of an inch to a foot, must be sent in duplicate, and must show—

(*a*) the boundaries of the site ;

(*b*) the position of the site in relation to neighbouring roads;

(*c*) the circle and holding number in which the building is proposed to be situated;

(*d*) the position of the building in relation to its own site, the proposed means of access, the proposed drains, privies, and cesspools, the purpose for which it is to be used, the elevation of the proposed building, the materials of the walls and of the roof, and the level of plinth. An elevation is not required in the case of a one storied tiled house.

(3) The application and site plan must be signed by the applicant.

20. After the receipt of any application for approval of site, or for permission to execute work or both, the Chairman may require the applicant—

(*a*) to furnish him with any information on matters referred to above which has not already been given in the documents received under these rules; or

(*b*) to satisfy him that there are no objections which may lawfully be taken, on any of the grounds mentioned above, to the approval of the site or to the grant of permission to execute the work.

21. The Chairman should ordinarily take action under section 21 within fifteen days of the receipt of the application.

22. The Chairman shall sign all passed plans in token of his approval.

PART VI.—Kucha Houses or Huts.

23. The building of all huts can be regulated by the Commissioners under the powers vested in them by Sections 236, 243, 244 and following ones of the Bengal Municipal Act.

APPENDIX E.

Calculation of re-payments of Loans by equal Instalments.

The annexed table shows the instalments by which a loan of one lakh of rupees will be refunded by periodical instalments in a given number of years, interest being calculated at 4, 4½, 5, 5½, 6 and 6¼ per cent.

In the left-hand column, under each term, interest is added, and recovery of the instalments due made at the end of each year ; in the right-hand column interest and instalment are supposed to be due half-yearly :—

Per cent.	Five Years.		Ten years.		Fifteen years.		Twenty years.		Twenty-five years.		Thirty years.	
	Year.	½ Year.	Year.	½ Year.								
4	22,463·0	11,132·4	12,329·2	6,115·65	8,994·14	4,464·96	7,358·18	3,655·55	6,401·21	3,182·32	5,783·01	2,876·78
4½	22,779·3	11,278·9	12,637·9	6,264·19	9,311·41	4,619·94	7,687·64	3,817·69	6,743·92	3,351·84	6,139·15	3,053·53
5	23,097·6	11,425·7	12,950·3	6,414·69	9,634·21	4,777·76	8,024·25	3,985·62	7,095·23	3,525·80	6,505·15	3,235·353
5½	23,417·6	11,574·5	13,266·7	6,567·2	9,962·6	4,938·6	8,367·9	4,153·2	7,454·9	3,704·2	6,880·5	3,422·0
6	23,740·0	11,723·0	13,586·8	6,712·6	10,296·3	5,101·9	8,718·4	4,326·2	7,822·6	3,886·5	7,264·9	3,613·3
6¼	23,901·3	11,798·1	13,748·2	6,799·5	10,465·0	5,184·7	8,986·2	4,414·0	8,009·5	3,979·3	7,460·3	3,710·6

APPENDIX F.

RULES FOR THE PREPARATION, SUBMISSION AND EXECUTION OF PROJECTS OF WATER-SUPPLY, SEWERAGE OR DRAINAGE BY LOCAL AUTHORITIES (AS MODIFIED UP TO THE 31ST JULY 1913).

Notification.

No. 818*T.-M.—The* 13*th September* 1910.—In exercise of the powers conferred by clauses (*i*) and (*ii*) of sub-section (1) of section 69 of the Bengal Municipal Act, 1884 (Bengal Act III of 1884), and by clauses (*e*) and (*m*) of section 138 of the Bengal Local Self-Government Act of 1885 (Bengal Act III of 1885), the Lieutenant-Governor is pleased to direct that the following rules for the preparation, submission and execution of projects for water-supply, sewerage or drainage by local authorities shall be substituted for the like rules published with Government Notification No. 1712M., dated the 7th July 1906, at pages 111 to 113, Part IB of the *Calcutta Gazette* of the 11th idem, namely :—

Preparation of sketch of project.

1. (*1*) Whenever a local authority desires to undertake a project for water-supply or sewerage or a comprehensive scheme of surface drainage, it shall first cause to be drawn up a sketch of the project roughly showing its scope and approximate cost.

(*2*) Such sketch may be drawn up either by the Sanitary Engineer at the special request of the local authority and with the approval of the Sanitary Board and on payment of the fees prescribed in Rule 8, or by any firm or person approved by the Sanitary Engineer.

(*3*) The Sanitary Engineer shall, in all cases, act as adviser of the local authority.

Submission of sketch, statement and application.

2. When the sketch of the project has been drawn up under Rule 1, and it is estimated to cost Rs. 10,000 or more, or in the case of an estimate of less than Rs. 10,000 if the financial assistance of Government is desired, the local authority shall submit it to the Sanitary Engineer, who shall make such recommendations as he may think fit. After the approval of the Sanitary Engineer has been obtained, the sketch project shall be submitted by the local authority

Government of Bihar and Orissa Notification No. 7682M., dated the 8th July 1913.

through the Sanitary Board to the Municipal Department of Government, together with a statement wherein shall be shown the amount of the funds available to meet the cost of the project, either from current revenue or by way of loan or from any other source.

In the case of schemes the total estimated cost of which is less than Rs. 10,000, not being part of a larger scheme and for which financial assistance from Government is not required, the sanction of Government need not be obtained, but if the local authorities so desire the scheme will be examined by the Sanitary Engineer.

Conditions precedent to grant of administrative approval.

3. In order to obtain administrative approval to the execution of the project the local authority shall satisfy Government—

(*1*) that the cost of maintenance of the projected work can be met by the local authority from revenue;

(*2*) that any loan required to meet the cost of the work can be repaid, together with the interest thereon, within the period that may be prescribed by the Government; and

(*3*) that the work can be done effectually in the manner and for the cost proposed.

Procedure after grant of administrative approval. Preparation of detailed plans and estimates.

4. When the administrative approval of Government has been obtained, and in no case before, the local authority may arrange for the preparation of detailed plans and estimates, and for this purpose may—

(*a*) cause the plans and estimates to be prepared by its own officers or by an officer specially appointed for the purpose and apply to the Sanitary Engineer for assistance in the selection and engagement of surveyors to carry out the work; or

(*b*) apply to the Sanitary Board for the services of the Sanitary Engineer; or

(*c*) apply to Government in the Public Works Department for the services of their officer; or

(*d*) apply to the District Board for the services of the District Engineer; or

(*e*) with the previous sanction of the Sanitary Board entrust the work to a private firm of established reputation.

In cases of (*a*), (*c*), (*d*) and (*e*), the plans and estimates while in course of preparation shall be subject to the examination and control of the Sanitary Engineer.

Submission of detailed plans and estimates to Government through Sanitary Board.

5. The plans and estimates shall, on completion, be forwarded in duplicate, to the Sanitary Board, together with a full report on the financial aspect of the scheme and the state of public feeling in regard to it, and, if a loan is required, with an application in the prescribed form. In the case of drainage schemes the estimates must be submitted in Sanitary Board's forms Nos. 21 and 22, copies of which may be obtained from the office of the Sanitary Engineer, and when the scheme has not been prepared in the Board's Office they shall be accompanied by full details of the calculations of the sizes and strength of the various works, and complete information as to the prices on which the estimates have been framed.

The Sanitary Board, after examining the plans, estimates, report and application, shall submit them to the Municipal Department of Government with an expression of their opinion on the merits of the scheme as finally drawn up.

Construction.

Conditions as to detailed engineering supervision.

6. Where the cost of the projected work is estimated to amount to Rs. 10,000 or more an adequate provision for detailed engineering supervision shall be a condition precedent to the grant of sanction by the Government.

In the absence of special sanction to the contrary, the local authority shall agree to such one of the following conditions as may be considered suitable in each case :—

(*a*) that the work shall be carried out by the Public Works Department if that Department can undertake it : in such cases an extra charge of 15 per cent. on the sanctioned estimates shall be made for supervision, unless the case is one of extraordinary difficulty, under which circumstances a higher charge may be imposed under the orders of Government ; or

(*b*) that arrangements shall be made with the District Board for the carrying out of the work under the supervision of the District Engineer and his staff ; or

(*c*) that the work shall be carried out under the supervision of an Engineer qualified for ap-

pointment as a District Engineer according to the rules under the Local Self-Government Act of 1885 (Ben. Act III of 1885) specially employed for the purpose; or

(*d*) that the work shall be carried out by private engineering firm of established reputation:

Provided that the local authority shall not advertise for tenders or enter into any contract or agreement for the execution of any works in connection with schemes or parts of schemes which have been sanctioned by Government under conditions (*b*), (*c*) or (*d*), until the specification and form of tender for such contract have been examined and approved by the Sanitary Engineer. No tender or contract for any such work shall be accepted until it has been submitted to the Sanitary Board and they have approved the acceptance thereof;

and further provided that when the work is carried out under condition (*d*), it shall be supervised by an officer appointed for the purpose by the local authority with the approval of the Sanitary Board, and shall, while in progress, be periodically inspected by the Sanitary Engineer.

Report by local authority to the Commissioner in case of small works.

7. Where the estimated cost of works amounts to less than Rs. 10,000, the local authority shall report, for the information of the Commissioner of the Division, the agency by which it is proposed to have the works carried out, and shall follow the instructions issued by him in the matter.

Fees.

Bengal Government Notification No. 333T.M., dated the 23rd May 1911.

8. The following fees shall be leviable by the Sanitary Board from local authorities for the work specified against each :—

(*a*) a fee of two per cent. on the estimated cost (excluding cost of surveys) of all projects and schemes, for which detailed estimates and drawings are prepared by the Sanitary Engineer;

(*b*) a fee of one-half per cent. on the first Rs. 20,000 and one-quarter per cent. of the balance of the estimated cost of schemes and projects, the detailed plans and estimates of which are examined by the Sanitary Engineer;

(*c*) a fee of two per cent. on the estimated cost of the works, when contract, drawings, specifications

and forms of tender are prepared by the Sanitary Engineer:

Provided that when both detailed estimates and drawings and contract drawings, specifications and forms of tender are prepared by the Sanitary Engineer, an inclusive fee shall be charged of three per cent. on the estimated cost of the works.

8*A*. As soon as the services for which fees are leviable under the preceding rule are rendered, the Sanitary Board shall through the District Magistrate, demand from the local authority concerned payment of the fees leviable therefor, and the Magistrate on receipt of notice of such demand shall recover the said fees and credit them in the local treasury in favour of the Public Works Department and inform the Accountant-General, *Bihar and Orissa*, and the Examiner of Local Accounts, *Bihar and Orissa*.

Bengal Government Notification No. 819M., dated the 10th April 1908.

Government of Bihar and Orissa Notification No. 7682M., dated the 8th July 1913.

9. When sketch projects are prepared by the Sanitary Engineer, no charge will be made for his services or those of his assistants, Government surveyors, draftsmen, and tracers; drawing materials and the instruments required for the work will also be provided at Government expense. But the local authorities will be required to render reasonable assistance on the spot in the way of survey coolies, supply of survey pegs, fixing bench marks, etc., and to pay the actual cost of the same. They will also be expected in each case to provide a suitable office properly furnished for the use of the surveyors and draftsmen.

Bengal Government Notification No. 333T.M., dated the 23rd May 1911.

APPENDIX G.

MUZAFFARPUR DISTRICT.

SHIUHAR ROAD No. 25, CLASS IA & IIA.

Report, Bridges & Culverts.

Consecutive Number.	Mileage.	Description.	Number of spans & length of each.	Lineal feet of water-way.	Height of H. F. L.	Square feet of water-way.	Width of roadway.	When constructed or arched over.	Dated when last repaired.	General condition of Bridges or Culverts.	Are any urgent repairs necessary.	REMARKS.
1	3	Masonry Culvert.	2×8	16	5	80	16'	arched 1888 —89				

APPENDIX H.

CORPORATION OF CALCUTTA.

Specification and conditions for surfacing roads MacCabe's Tar-Macadam.

Materials.

1. MacCabe's tar-mac consists of 2 inches Pakoor stone metal, MacCabe's patent bituminous binder of Gas Co.'s coal tar and "Stag" brand English coal pitch in the proportion of one of tar to three of pitch by weight, with stone chippings and sand as top binder.

Preparation of the Foundation.

2. Prior to resurfacing an old stone road with the composition all irregularities in its surface, gradients or crow-fall should be corrected, and special care taken to rectify defects, if any, in all its drainage and water adjuncts, and also remedy any weakness in the foundation due to bad restoration by the road cutting agencies.

Rules for Surfacing Roads.

3. (i) Collect all necessary aforesaid materials including tools and implements for laying them *in situ*.

(ii) Sketch out the road area to be treated in convenient sections.

(iii) Suspend road watering on the previous day in the section to be treated first and barricade or fence it off.

(iv) Thread out the area to be treated with the patent composition, as this will avoid feather edge in the centre tar-mac joint.

(v) Form separate labour gangs for—

(*a*) Weighing, mixing, and heating pitch and tar—three men for each tar-heating boiler or cylinder.

(*b*) General cleaning and sweeping with rough country or English bass brooms, and removing fine dust off the road surface before treatment by means of soft floor brush.

(*c*) Carrying pitch and tar composition in pails or buckets and laying it hot half inch thick on dry and clean road surface.

(*d*) Carrying stone metal in cane baskets, spreading and hand-packing the same carefully to the required chamber, one man for every three feet of road width to be so treated.

ROLLING.

4. The work of rolling the surface should be commenced as soon as a section of about 20 or 30 yards in length has been laid, the metalling gang being kept as busily employed as possible in laying a further length of materials in the way specified above. The prepared road surface is to be rolled with a light six or ten-ton roller when the composition is soft, as it is absolutely necessary to press the aggregate gently down into the bituminous sub-binder, and at the same time to entice (rather than to force) the latter in an upward direction, so as to fill the voids in the metal and finally cover the metalled surface. Under no circumstances should the rolling be carried to such a point that the metal exhibits signs of crushing or disintegration. The roller should be driven over the newly laid materials at its lowest speed from the side towards the centre and after a few journeys over the surface if it is found that the sub-binder is not working up between the voids in the metal and does not cover the metal surface, then such defective places have to be painted and the whole surface sealed with composition to prevent the admission of moisture or of any foreign substance into the road. During the process of consolidation stone chippings at the rate of 4 cubic feet per hundred square feet should be used and especially where the floated composition is too soft. If it is found that any material sticks to the roller wheels a little water sprinkled on the wheels will at once stop the sticking. The dry surface may be also sanded if it becomes slippery for horses.

5. All materials to be supplied must be to the satisfaction of the Engineer. Inferior materials supplied shall be rejected and the contractor must make good such supply within 24 hours. In default it shall be competent to the Engineer to procure a supply of the same at the risk and cost of the contractor from the market or any other agency.

6. The contractor must maintain the roadway for three months after completion and keep men in attendance to promptly spread stone chips and road dust on the soft portions and nurse the area cut up by the traffic.

7. The contractor must be careful not to injure existing gas, water or any other pipes or drains or other underground fixtures. Any damage so caused must be forthwith reported to the District Engineer, and the contractor shall make good the same forthwith at his own cost and shall indemnify and keep indemnified the Corporation from all claims made therefor. When necessary he shall take up and carefully relay drains and pipes and lay any additional length that may be ordered by the Engineer at the cost of the Corporation.

8. The contractor must keep the work properly fenced and lighted from sun-set to sun-rise, and place such watchmen at any portion of the road and footpath in which the work is in progress and is still incomplete, and also round the repairing materials for use, as may be necessary to protect the public against accidents. He shall indemnify and keep indemnified the Corporation and its officers and servants from all liability in respect of any claims for damages or otherwise to person or property which may be made by any person or persons on account of any act, misfeasance or neglect on the part of the contractor in carrying on the work or in connection therewith.

9. The contract will be for four months and the contractors must carry out all works in accordance with the full programme of work prepared by the Engineer and take in hand such street or streets as the Engineer may direct and complete the same within such period as the Engineer may fix therefor. In default he shall pay to the Corporation liquidated or settled damages of Rs. 10 (ten) per diem for each and every day beyond the said period without prejudice to the rights of the Chairman to cancel the contract and take possession of the work and have it carried on and completed at the contractor's risk and cost by any agency whatever.

10. All damages or other sums due and payable by the contractor may be received from any moneys due to the contractor by the Corporation.

11. Payments will be made in accordance with the terms of the agreement.

12. The Commissioners do not bind themselves to accept the lowest or any tender, but reserve the right of accepting the whole or part of the tender.

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